MECHANICAL ENGINEERING

INCLUDING THE ENGINEERING INDEX

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Contributors and Contributions

Steam-Condensing Plants

In a paper read before the Baltimore Section of the A.S.M.E. and printed in this issue of Mechanical Engineering, Paul A. Bancel outlines the economical operating requirements for surface condensers and presents a design to satisfy these requirements. Mr. Bancel was graduated from Cornell University in 1909 and from that time until 1917 was engaged by the George H. Gibson Company in the commercial development and advertising of engineering lines. He has been interested in condenser design for many years, obtaining numerous condenser patents and contributing frequently to the technical press on this subject. In 1917 he was engaged by the Ingersoll-Rand Company to carry on research and develop a projected condenser design.

Centrifugal Casting

The utilization of centrifugal force in the casting of metal is a development that is attracting considerable attention. In an Annual Meeting paper to be presented by Robert F. Wood and abstracted in this issue of Mechanical Engineering, the author discusses the effect of rotation speed and inclination of the axis of the mold upon the characteristics of the casting. Mr. Wood was graduated from Williams College in 1904 and completed his studies at the Michigan College of Mines in 1906, receiving the degrees of Bachelor of Science and Mining Engineer. He spent one year in the gold and silver mines of Mexico, and eight years as chemist and metallurgist for the Quincy Smelting Works of Hancock, Mich. In 1916 he became metallurgist and foundry superintendent of the Sandusky Foundry and Machine Company, whose specialty was centrifugally cast bronze and brass tubes for paper-mill rolls. Since 1920 Mr. Wood has acted as metallurgist for the Monel Products Corporation, of Bayonne, N. J. He is a member of the A.I.M.E.

Papers for Fuel Waste Session

The subject of Waste Elimination will be treated by the various Professional Divisions at the 1921 A.S.M.E. Annual Meeting. The contribution of the Fuels Division to this topic will be extremely valuable and three of the papers to be given, by Victor J. Azbe, Joseph Harrington and W. B. Chapman, are printed in this issue.

Mr. Azbe has had nine years' experience in the operation of boiler plants with Swift and Company and the Anheuser-Busch Brewing Company where he supervised the testing. Since 1918 he has been engaged in consulting work in St. Louis, Mo.

Mr. Harrington was graduated from M.I.T. in 1896. After varied experience in machine-shop work, mining, and machine design, he came to the Green Engineering Company of Chicago, in 1901 and served as designer, erector, superintendent and chief engineer. During this time he developed the coking coal chain grate, the Harrington automatic stoker and the adjustable ash controller. Since 1914 he has practiced as a consulting combustion engineer, with offices in Chicago.

Mr. Chapman is a graduate of Oberlin College. He spent five years in civil engineering work for the city of Cleveland and the Big Four Railroad. From 1898 to 1905 he was engaged in designing and building chemical works in Michigan. Since 1905 he has been president of the Chapman Engineering Company, engaged in the solution of the mechanical problem of handling coal, fire and ash in gas producers.

Locomotive Design

The Railroad Waste Session at the Annual Meeting will treat avoidable wastes in the design and operation of locomotives and cars. The Avoidable Wastes in Locomotives Affected by Design will be presented by James Partington, estimating engineer for the American Locomotive Company. Mr. Partington has been in the employ of this concern since 1901 and has been engaged in designing and estimating. Previous to that date he served as draftsman and estimater at the Pittsburgh Locomotive Works.

Reducing Waste in Human Effort

Walter N. Polakov will emphasize the importance of making work fascinating at the Annual Meeting session on Management Waste. Mr. Polakov, a graduate of the Dresden Technical High School, had considerable marine and shop experience in Russia prior to his arrival in this country. From 1907 to 1916 he was associated with Harrington Emerson, Henry L. Gantt and Day and Zimmerman in the power-plant and management fields. Since 1916 Mr. Polakov has maintained his own consulting practice.

Industries in Russia

Mr. Royal R. Keely, who has recently returned from two years in Russia, presents for us in this issue a few facts about the industrial situation in that country which should be of great interest to every reader of Mechanical Engineering. Mr. Keely is an engineer who has had experience in the problems of the industries of this country and his observations and conclusions will therefore add materially to our knowledge of Russia and its problems.

Editorial Page

This issue contains two editorials that furnish food for careful engineering thought. Mortimer E. Cooley, Dean of the Colleges of Engineering and Architecture at the University of Michigan and newly elected president of the American Engineering Council, points out the relation of the engineer to public utilities. Arthur D. Little of Boston emphasizes the need of close coöperation between the chemist and the mechanical engineer.

A.S.M.E. ANNUAL MEETING
New York, Dec. 5-9, 1921

Engineering phases of problems involved in Elimination of Industrial Waste to be discussed by Professional Divisions. For details of Professional Program and Social Events see pages 754-755 of Section I.

Section II of this issue relates some of the plans of the Local Sections and Professional Divisions.

MECHANICAL ENGINEERING

Volume 43 November, 1921 Number 11

Steam-Condensing Plants

A Detailed Consideration of the Fixed and Operating Charges in Surface-Condenser Installations, and Description of a New Type of High-Efficiency Condenser

By PAUL A. BANCEL,[1] NEW YORK, N. Y.

The heart of a power plant lies in the boiler room, and the most important aspect of the condensing plant is in its relation to boiler-room costs. The choice of a condenser may be said to rest largely on its influence in reducing boiler-room charges. As indicated in Fig. 1, it would pay to run condensing if coal cost nothing; and pay even more, if the boiler feed was poor or expensive, to install the costliest of condensers—the surface type. With pure feedwater there is less fuel loss and boiler-maintenance charges, and, what is of still greater importance, boilers may be driven at higher ratings with consequent further reductions in first costs and fixed charges.

The designer of a power house is in a quandary—flying from boiler evils to condenser evils, and often with hesitancy as to which are the less serious. The problem is one of balancing fixed and operating charges in the boiler room against similar charges in the condensing plant.

Fixed Charges

The fixed charges against a surface-condensing plant depend on—

a Vacuum desired, which influences the size and cost of the equipment

b Cost of tube replacement, which depends on amount of tube surface in any particular design and life of the tubes as influenced by water conditions and condenser design

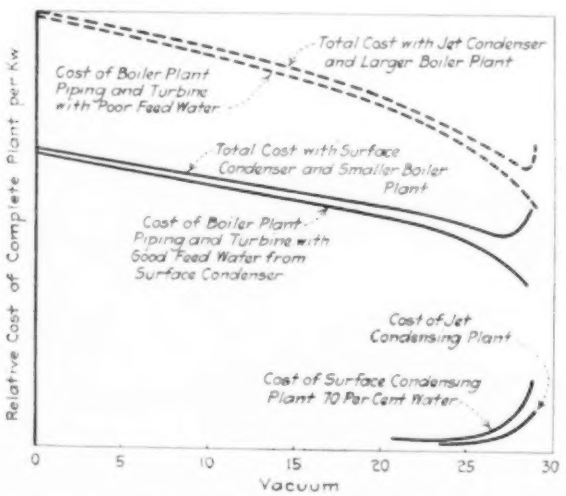

Fig. 1 Relative First Cost of Steam Power Plant at Different Vacuums

c Power for the auxiliaries, which increases if the cost and fixed charges are reduced.

Vacuum. In Fig. 2 the curve 0-0-0 shows the absolute back pressures at the turbine exhaust which might be expected from a cycle of water temperatures and a certain investment in condenser. Frequently the design of the turbine is such and the water temperatures in the winter are so low that for certain winter periods a vacuum is obtained which is better than can be utilized by the turbine. On the other hand, the temperature of the available water supply for three to six months of the summer is 60 to 80 deg., so that the vacuums obtainable are lower than are desirable for maximum turbine economy. Area *C* in Fig. 2 indicates the range of vacuums by investing more or less money.

As will be seen later, extensive calculations in regard to best investment are apt to be misleading because of the reduction in vacuum which so often occurs due to fouling of the tubes. In such instances all other questions become subordinate to that of maintaining high vacuum continuously, under actual operating conditions. In other cases the decision must rest on the relation

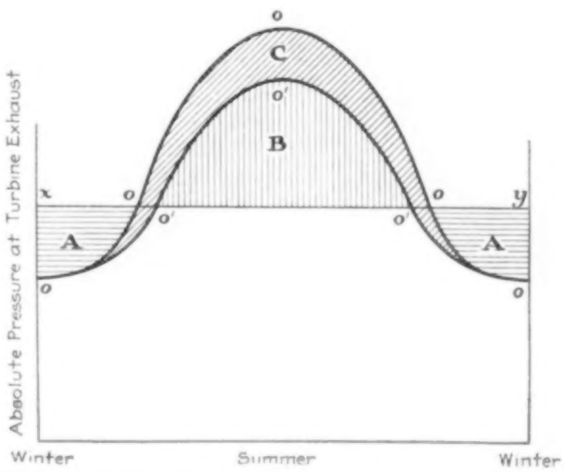

Fig. 2 Cycle of Absolute Back Pressure of Year

Line x-y represent highest vacuum or lowest desirable exhaust pressure. Areas A,A represent waste in winter due to excessive vacuum and areas B and C waste in summer due to warm water and insufficient vacuum. Area C indicates improvement possible by investing more money.

of load factor, months of the year having hot water and the fixed charges and operating charges at different vacuums.

Cost of Tube Replacement. This can be set up as a yearly depreciation reserve. The life of a condensing plant might be 20 years, whereas the tube life might be only five. On a 10,000-kw. turbine this might necessitate the purchase every five years of tubes costing about $10,000. Thus in determining the best vacuum the item of tube renewals may have a preponderating influence. Furthermore, as between two condensers for the same vacuum, one of which requires less tubes than the other, it is manifest that the fewer the tubes the less the fixed charges.

Similarly, the longer the tube life the smaller the fixed charges and cost of power. In one plant the tube life might be five years and in others a great deal more or a great deal less. Tube life depends on the character of the water supply, on the chemical, physical and metallographic properties of the tubes (crystalline structure) and it also depends on the design of the condenser. The latest report of the Corrosion Committee of the Institute of Metals, London, summarizes the types of condenser-tube corrosion, principally general thinning, pitting and apparent dezincification. The fourth and fifth reports of this Corrosion Committee are exhaustive studies of the subject, and among other causes

[1] Ingersoll-Rand Company, New York, N. Y., Jun. Am.Soc.M.E.

Presented at a meeting of the Baltimore Section of The American Society of Mechanical Engineers, May 16, 1921. Slightly abridged.

emphasize the effect on corrosion of low velocity and high temperature.[1]

Velocity has a direct effect on corrosion. Low velocity allows the deposit of foreign matter in the tubes which forms obstructions around which the products of corrosion accumulate in concentrated form, with the resultant pitting. High water velocity keeps the tubes clean and eliminates this form of corrosion.

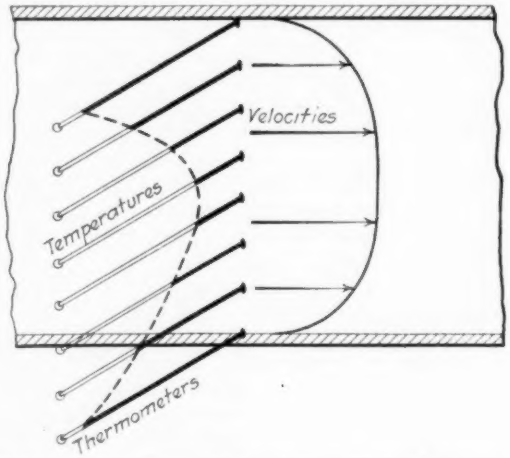

Fig. 3 Influence of Water Velocity and Tube Diameter on Temperature Distribution

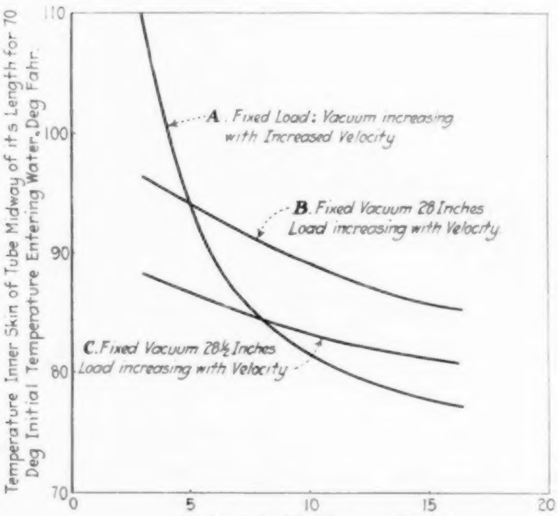

Fig. 4 Relation of Skin Temperature to Water Velocity at Different Loads and Vacuums

High temperature accelerates corrosion of all types and so seriously that a temperature of 95 deg. fahr. is recommended as the maximum. There are three ways of reducing temperatures in order to alleviate corrosion: by increasing the water quantity, thus decreasing the overall rise; second, by eliminating hot spots and local overheating of tubes; third, by increasing water velocity or decreasing tube size, thus decreasing the skin temperature at the tube wall. The first of these needs no comment. As to the second, it is well known that faulty steam distribution causes excessive heating of the water in some tubes counterbalanced by practically no heating of other tubes. Thus in condensers in which the steam distribution is obtained by lanes, the tubes in the path of the steam heat the water rapidly, but they short-circuit the tubes within the banks. The short-circuited tubes are not only wasted surface, but are the cause of the excessive temperatures in the exposed tubes, which consequently corrode rapidly.

The third method of reducing temperature, higher velocity and smaller tube size, may need explanation. It is well known that more heat is transferred for a fixed area of tube surface and fixed conditions of steam temperature and water temperature, if water velocity is increased or tube diameter reduced. The tube acts as though a colder water supply were being used, and this is exactly what is happening because the water at the walls is really colder. The metal is therefore colder and can abstract more heat in the same time from steam at the same temperature.

The flow of water in a tube is accompanied by cross-currents and whirls which convey the heat from the walls into the body of the water. In Fig. 3, if thermometers were placed as indicated the temperature readings would follow a curve as shown. Increased velocity reduces the temperature at the walls, making the curve flatter. Similarly, using a smaller tube reduces the temperature at the walls and makes the temperature gradient flatter. The inner skin temperature may be approximated from

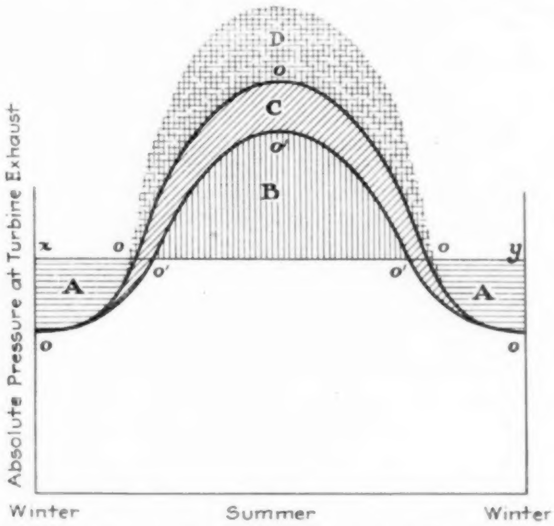

Fig. 5 Cycle of Absolute Back Pressures at Different Seasons
Area *D* shows increased back pressure or loss of vacuum due to fouling.

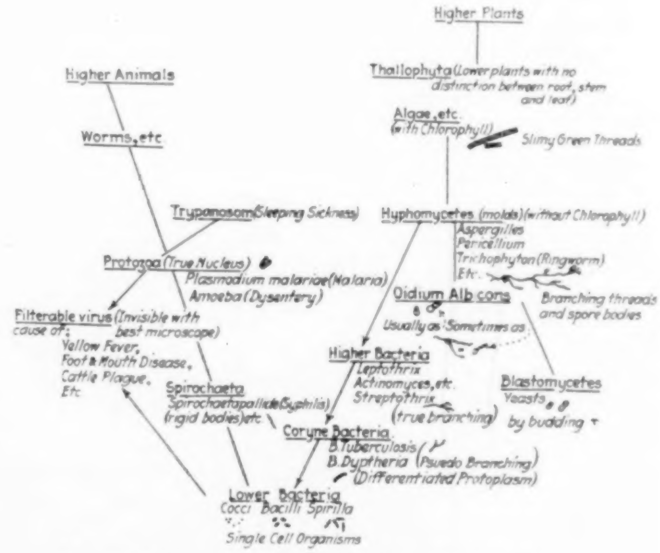

Fig. 6 Forms of Life in Condenser-Tube Slime

various experimental results on heat transmission and curves obtained as in Fig. 4, which shows the relation between the water velocity and this inner skin temperature for conditions of constant load (Curve A) and constant vacuum (Curves B and C). In all cases increasing the velocity reduces this temperature.

In a condenser with proper distribution to avoid hot spots, and with suitable velocity and tube diameter to further reduce skin temperature and prevent foreign deposits, a markedly longer life of tubes will be obtained. As will be seen, too, these features of design result in small initial surface requirements, so that there is a twofold reduction in the fixed charges to take care of replacements.

[1] Jour. Inst. of Metals, vol. 23, p. 76.

Operating Charges

The principal operating charges on a condensing plant may be grouped as follows:

a Reduction of condensate temperature below steam temperature and consequent loss of coal

b Power for operating the auxiliaries

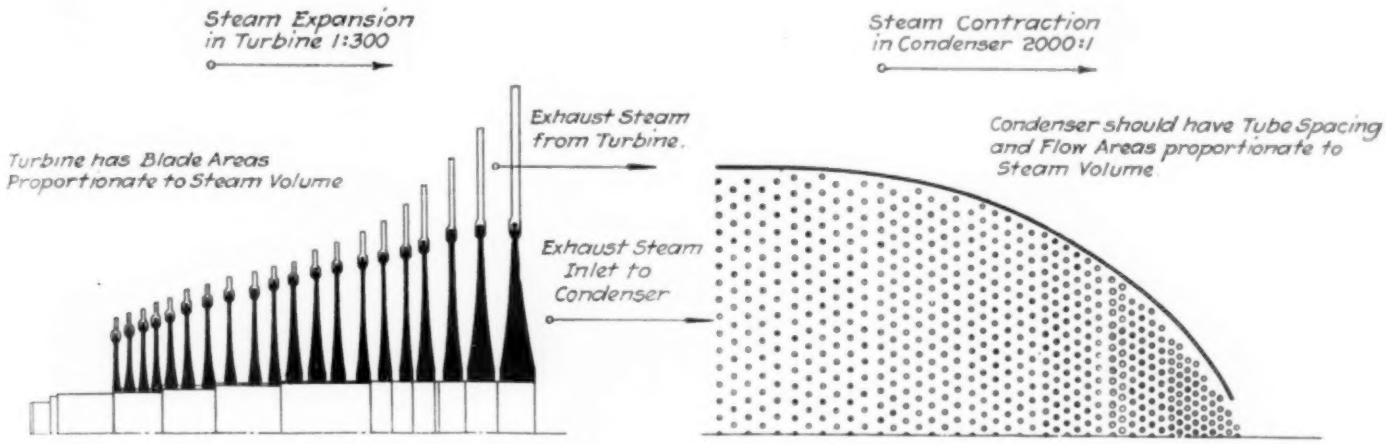

Fig. 7 Comparison of Steam Flow in Turbine and Correctly Designed Condenser

c Reduction of vacuum and increased coal consumption due to scaling and sliming of the tubes

d Cost and time lost to clean the tubes and cost and time lost due to tube failure and consequent pollution of the boiler feed.

Reduction or Depression in Condensate Temperature below steam temperature depends on condenser design and temperature of circulating water, being less with warm water and greater with cold water. The water of condensation must fall over successive rows of tubes to reach the bottom and if the steam is not drawn down to the bottom of the condenser, the water will be gradually cooled. The colder the water and higher the vacuum the greater the proportion of idle surface and the colder the condensate. Even in those condensers, in which numerous short-circuiting lanes are provided for the express purpose of securing penetration of the steam, there is a depression of condensate temperature of 5 to 10 deg. in summer and 10 to 20 deg. in winter. Eleven degrees loss of condensate temperature represents 1 per cent loss of efficiency and is equivalent to 300 kw. on a 30,000-kw. machine. In some plants this loss is largely overcome by the installation of preheaters.

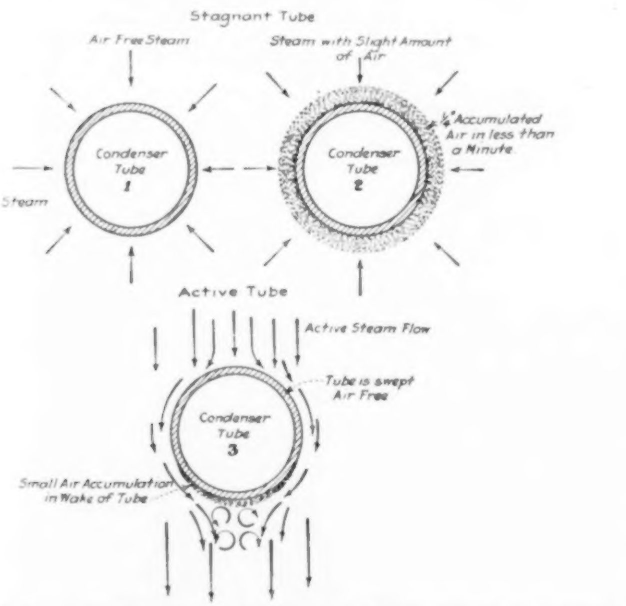

Fig. 8 Importance of Steam Velocity in Preventing Stratification of Air around a Condenser Tube

Stagnant Tube: Condition when steam flow is produced by avidity of tube itself for condensing steam.

Active Tube: Condition when there is active steam flow to sweep tube free of air.

Power for Operating the Auxiliaries has already been considered in a sense in the discussion of fixed charges, since the power required for any vacuum is partly dependent on the investment, and may be decreased by increasing the investment and fixed charges. No distinction should be made between the power required for driving condenser auxiliaries and the main power output of the plant, even where the auxiliaries are steam-driven and exhaust to a feed heater. The auxiliary power is a direct charge against the main unit output.

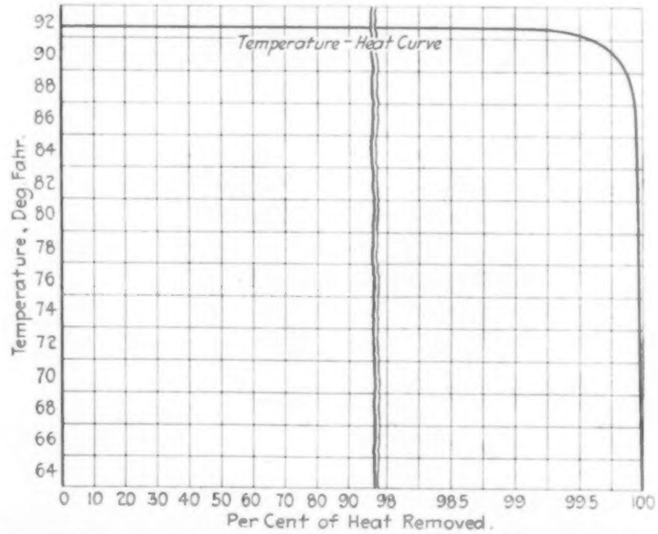

Fig. 9 Relation between Percentage of Heat Removed from a Mixture of Steam and Air and Temperature of the Mixture

Note scale is magnified 40 times at right-hand section of chart for the assumed mixture which is a fair average in high-vacuum condensers; the temperature starts to fall at 99 per cent.

The principal item of power consumption lies in the circulating pump, and this unit is often arranged for variable-speed drive or else is divided into two smaller units, so that with cold water or light load the operating charge may be reduced by slowing down or by shutting down one pump. As shown in Fig. 2, an excessive vacuum is obtainable in the winter and the waste of fixed charges can be partially offset by saving on the circulating-pump power.

The best balance of circulating-pump power in the summer time for conditions of maximum water temperature and full load must be settled after consideration of all the aspects of the problem. By proportioning the condenser for low water velocities the head on the circulating pump may be made low, and the quantity of water used very low with small power requirement for driving the pump. This saving, however, may be counterbalanced by

excessive fixed charges distributed over a relatively small part of the year. Thus suppose the investment were increased \$5,000 on a 10,000-kw. unit, and the circulating-pump power reduced by 50 kw. The added fixed charges including tube renewals might be \$1000 per year, and if this be charged against the summer months, the rate might be 50 cents to several dollars per hour depending on the number of hours. This would offset 50 kw. For this reason many plants use two pumps in the summer, working under relatively high heads of 30 to 40 ft.

Low pump power with low water velocities may be offset also by increased operating charges due to low vacuum resulting from fouling. Fig. 5 is similar to Fig. 2, except that a shaded portion D has been added to indicate the range of vacuum in the summer time under actual conditions of fouling of condenser tubes. As much as an inch of vacuum is lost in a week in some cases, and in one extreme instance there is a loss of an inch in two days. It is unfortunate that the loss by fouling is most severe in the summer when it is most difficult to obtain high vacuum. As a reduction of only $^1/_4$ in. in vacuum represents a loss of $1^1/_2$ to 2 per cent of turbine economy, which may be equivalent to all the auxiliary power, it is readily seen how easily all calculations of exact balance between fixed charges against the condenser and operating charges against the auxiliaries may be disrupted.

Reduction in Vacuum Due to Tube Fouling. The foreign matter that accumulates in condenser tubes may be divided into three classes:

a Mechanical deposits, silt and mud
b Scales deposited out of solution
c Slimes or organic growths.

The first of these is of minor influence in reducing vacuum unless water velocities are low indeed. The ability of a stream of water to carry solid substances in suspension increases rapidly with increase of the velocity. However, foreign matter such as silt, may be deposited in slime coatings which form a more adherent surface than a clean condenser tube.

The second form of deposits is common with salt water and hard waters carrying scale-forming salts, familiar in impure boiler feedwater. In many cases with cooling towers or spray ponds the source of make-up is a relatively hard water and causes deposits of sludge and scales in the condenser tubes. The commonest ingredients of such water are calcium and magnesium carbonate which are soluble in the presence of carbon dioxide. Heating the water drives off the CO_2 and precipitates the carbonates.

The influence of uniform steam distribution, smaller tube size and high water velocity on reducing skin temperatures has already been shown. It is also probable that high velocity has a mechanical effect in reducing the rapidity of such scale formations. In sugar evaporators it is commonly found that the tubes which work actively and therefore contain rapidly rising currents of mixed vapor and juice, scale the least; whereas tubes doing less evaporation foul more heavily.

Where extremely hard waters are encountered it is desirable not only to keep down the temperatures by observing the principles of high skin velocity and activity, but also by using larger quantities of water and smaller overall temperature rise. In this way it is possible as between two condensing plants to reduce the maximum temperature rise of the skin of water in the hottest tubes, 10 or 20 deg., or even more.

Slimes or organic growths are the third form of deposits. Fouling of this character is most severe in the summer time, and is also most severe in hot portions of a condenser with improper steam distribution. Thus, in a condenser with lanes, the tubes in the lanes will be found coated with a thick, heavy slime in a short time, whereas tubes in the short-circuited regions will be but slightly fouled. It is probable that these slimes are organic growths occurring under the ideal conditions of warmth and stagnation existing at the inner skin of the tube. A typical sample of condenser-tube slime was taken a short time ago by the author and given to a bacteriologist for analysis. A large number of hyphomycetes were demonstrated. This form of life is classified between bacteria and plants, as shown in Fig. 6. The hyphomycetes grow rapidly as long microscopic threads (Mycelia), which branch rapidly, forming a dense interlacing network in which all other organic and inorganic elements are caught. They grow better in an acid than an alkaline medium. The hyphomycetes are familiar to us as molds and fungi and are a form of life just below the algæ, which are the green slimes frequently seen in stagnant pools. The algæ contain chlorophyl and require light for their growth, whereas the hyphomycetes grow in the dark. The conditions for rapid growth are moisture, stagnation and a fair warmth. The optimum temperature is between 20 and 40 deg. cent. (68–104 deg. fahr.); when spores are formed they are more resistant to higher temperatures.

There are cases on record of two condensers side by side, one with low velocity the other with high velocity, in which the latter remains cleaner for longer periods. Similarly it is well known that condensers do not lose as much vacuum or have to be cleaned as frequently in the winter as in the summer, and also that those parts of the condenser that are hot foul more rapidly than those where the water is not heated. In one instance a condenser is so large that it is cleaned only part at a time, and when this practice was initiated the operating force found that cleaning the two lower quarters and one upper quarter improved the vacuum very slightly, whereas cleaning the last quarter which was exposed to

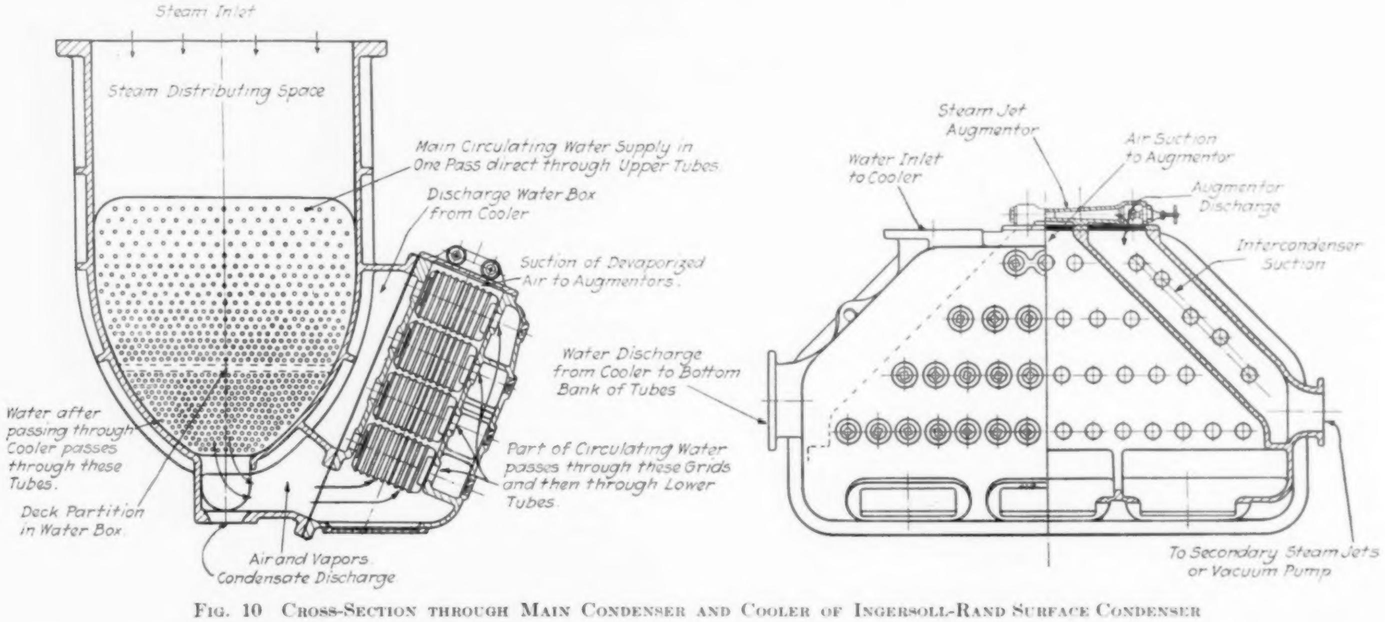

FIG. 10 CROSS-SECTION THROUGH MAIN CONDENSER AND COOLER OF INGERSOLL-RAND SURFACE CONDENSER

the full activity of the steam brought the vacuum back to normal. In this section, the tubes exposed to steam are so heavily fouled that two men are needed sometimes to push the brushes through. The same arrangement of tubes top revent local overheating, and the use of high water velocities to reduce inner skin temperatures and increase the activity and counteract stagnation along the inner wall of the tube, may be expected, therefore, to reduce and eliminate the formation of organic slimes. Corrosion, scaling and sliming can all be reduced by correct proportion of a condenser for high activity of water flow and turbulence at the tube wall and uniform steam distribution, factors which in addition permit of a large reduction in the amount of tube surface.

Fouling adds to the operating charges in another way, as there may be a large labor cost for cleaning. The time loss with a unit out of service is also a considerable item of cost. The charges due to failure of tubes by splitting and corrosion are of a similar nature. The pollution of the condensate and consequent scaling of the boilers from either impure condensate or from raw feedwater adds to the operating charge in the boiler room. The loss of time on the complete power-generating unit required to shut down, locate, and plug the leaking tube adds to the turbine-room operating charges.

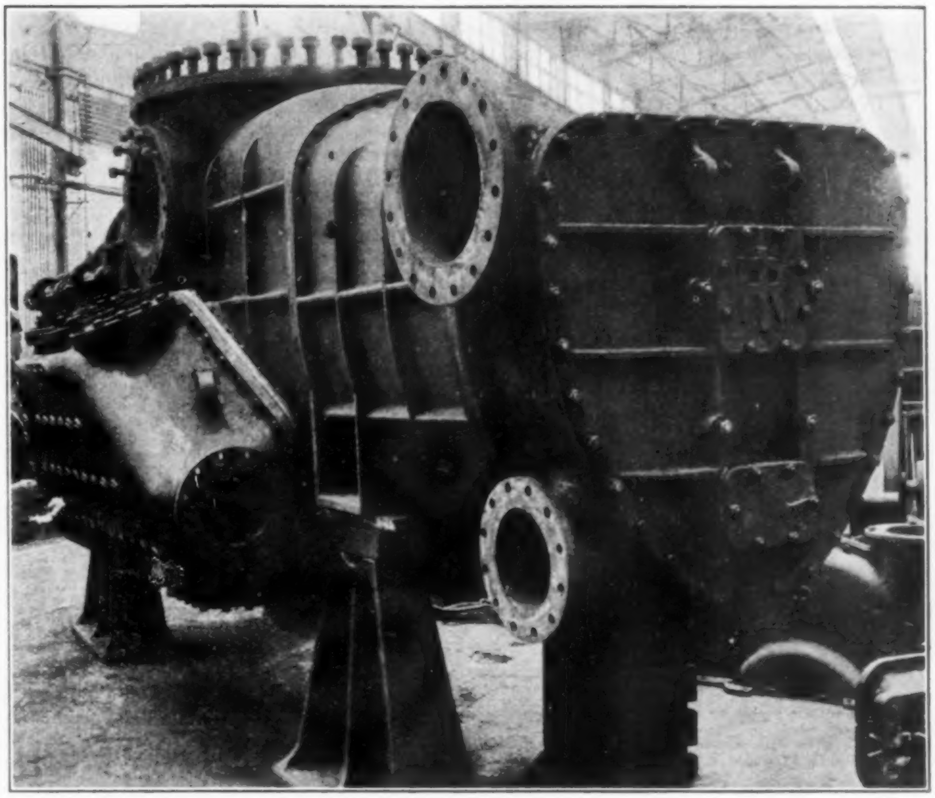

Fig. 12 Ingersoll-Rand Surface Condenser from Inlet Water-Box End
At the left is the cooler, mounted on shell.

Clogging of Tubes. One other loss adding to operating charge is that caused by clogging of tubes by accumulation of miscellaneous solid substances against the tube sheet. This applies only to plants using natural water supplies. With spray ponds the nozzles clog long before the condenser tubes. Clogging can be reduced by proper screening, and the use of flush, well-rounded tube inlets and high water velocities. Low velocities are wanted in the screens, but high velocities and clear inlets into the tubes. The influence of velocity is clearly shown by the tendency in two-pass condensers for the tubes of the return pass to clog with solid matter which originally came through the first pass. This clogging is most noticeable toward the top (where the water is needed most) and is due no doubt to the slow velocities at the top of the return box, which is at the top of the siphon and acts as a skimming tank.

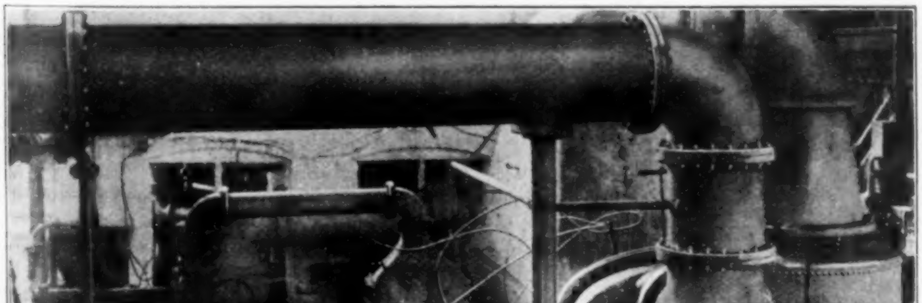

Fig. 11 Large Experimental Surface-Condenser Plant at Works of the Ingersoll-Rand Co., Phillipsburg, N. J.

Condenser Design

The design of a surface condenser to conform with the requirements which have been outlined, lies in the proper application of certain well-known principles. The first of these is to keep all of the tubes uniformly hot on the steam side so that the minimum number will be needed because none is wasted. To accomplish this the steam must be free to flow to all the tubes and over all the tubes, with slight loss of pressure and temperature, the condenser being arranged in stages, much as is a turbine, with large flow areas at the exhaust entrance and great distances between rows to avoid sharp bends and pressure loss. Fig. 7 illustrates the analogy.

Of equal importance in keeping all tubes hot is the proper staging to maintain velocities that will sweep the air ahead in the current of steam and the arrangement of tubes in staggered rows so that none is shielded or pocketed. Air left on a tube after condensation would otherwise stratify in a thick layer in a few seconds. With rapid steam velocities as shown in Fig. 8, all of the tube is hot because the air is continually carried away in the current of steam. Experiment has shown that this current is most active in producing heat transfer in front of the tube; the side about 90 per cent active, and the back about 75

per cent. This indicates the importance of a staggered tube arrangement so that the front of each tube is presented to the steam flow.

The steam velocities must be sustained throughout the depth of the condenser, which not only requires proper tube spacing but a shell of decreasing width—that is, a wedge- or heart-shaped shell terminating in a narrow, slot-shaped outlet. In this respect also the condenser is analogous to the turbine, Fig. 7, which has both changing blade height and changing wheel diameters.[1]

If the foregoing conditions are maintained, the mixture of steam and air is kept homogeneous and the temperature does not fall until a surprisingly large percentage of steam has been abstracted and the process almost completed. Fig. 9 shows the relation between percentage of heat removed from an average steam-air mixture such as would enter a condenser, and the temperature of the mixture. Starting with approximately 92 deg. temperature there is no perceptible fall of temperature due to increasing air richness until over 99 per cent of the heat has been abstracted and over 99 per cent of the steam condensed. Thereafter the temperature falls with a marked knee in the curve, the exact position and shape of which depend on the proportion of air to steam in the original mixture.

This process is *no longer rapid condensation but a matter of devaporization*, to reduce vapor temperature and pressure and increase partial air pressure so that the air may be removed by a vacuum pump. It is best carried out in a chamber external to the main condenser forming a devaporizer or cooler. Figs. 10, 11, and 12 illustrate such an arrangement in which the flow of hot vapors and air taken from the bottom of the main condensing chamber are turned upward into a cooler from which the concentrated air is finally removed at the top. It will be noticed that

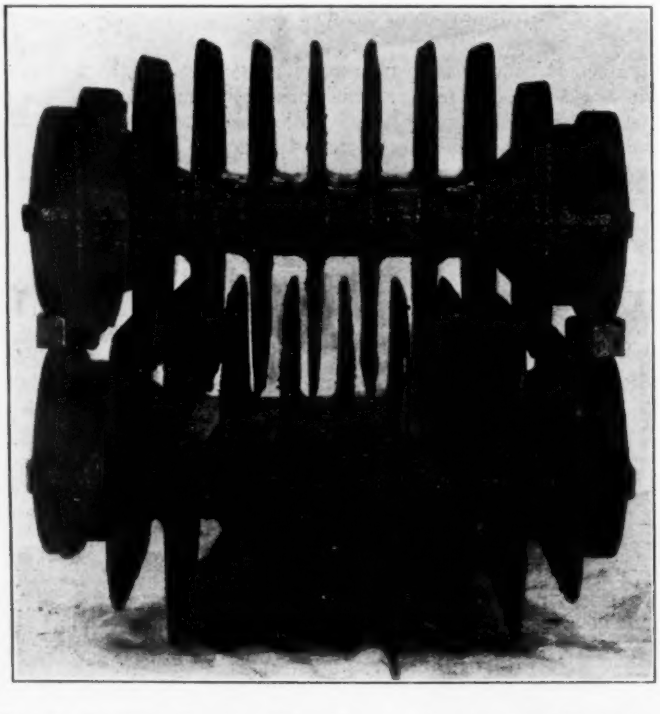

Fig. 13 Showing Grids as Meshed when Assembled in Condenser Cooler

this cooler is also of wedge shape, decreasing in area as the outlet is approached. The air is withdrawn by steam-jet augmenters which discharge into an intercondenser section forming part of the cooler. The air at reduced vacuum is then withdrawn and compressed to atmosphere by secondary steam jets or a small reciprocating pump. In one case a single small pump is used as a secondary for two condensers, steam-jet secondaries being installed as stand-bys.

[1] Wedge-shaped shells have been in use for many years with Weir's marine condenser. The earliest record of this type of shell known to the author is that of its use 33 years ago by another English manufacturer.

The work of devaporization is done by cast-iron grids with fins, meshed together as illustrated in Fig. 13. Cold circulating water flows through the cores of the grids with only slight rise in temperature and then passes through the bottom group of tubes in the condenser (Fig. 10).

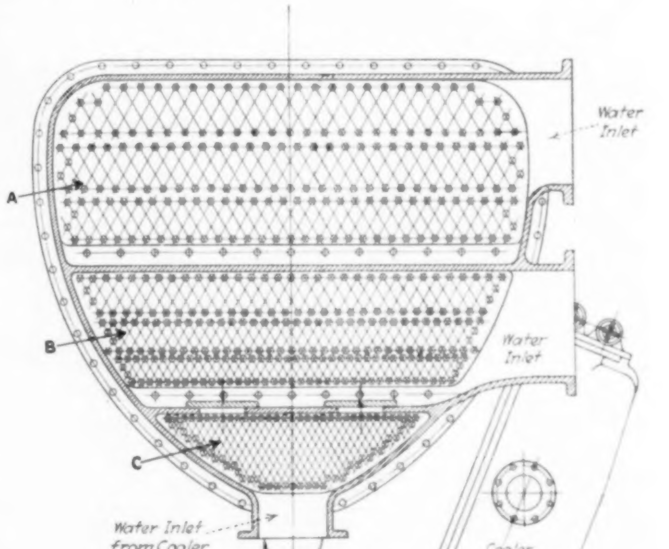

Fig. 14 Water Box with Two Injection Nozzles on I.-R. Surface Condenser

Both nozzles are used in summer, the upper one only in winter, thus obtaining high water velocity even with reduced water quantities and concentrating condensing action in top of condenser.

A large experimental plant, for capacities up to 70,000 lb. per hour was built at the Phillipsburg works of the Ingersoll-Rand Company to investigate these departures in design. The photograph reproduced in Fig. 11 illustrates the complete plant. By the use of electrical thermometers the performance of each row of tubes was determined and from that the efficiency of the tubes under all conditions of loads, vacuum and air leakage and in different parts of the condenser. A sliding or "trombone" thermometer of the electrical resistance type in the discharge water box was arranged so that it could be shifted to any position desired. Decks were fitted in the box which could be shifted to vary the water distribution so that a wide range of conditions of water circulation were obtained. It was found that high efficiency was obtained down to the last row of tubes of the condenser so long as certain critical conditions of vapor velocity were maintained. The condenser was hot throughout its depth and the condensate water at practically steam temperature. The hydrodynamic loss or pressure drop was also studied by the use of water manometers, from which the important relations of pressure loss, steam velocities, tube spacings, and number of rows were determined.

Depending on the air leakage, the cooler devaporizes and cools the air down as close to the temperature of the cold circulating water as one degree, thus giving complete countercurrent action. A study of these temperatures was made by electrical thermometers located at successive points as shown. As is well known from Dalton's law, the amount of air contained in a homogeneous flowing mixture of steam and air depends on the partial air pressure, which in turn depends on the temperature and corresponding partial vapor pressure, so that complete countercurrent action gives maximum withdrawal capacity of the vacuum pump and protection against excessive reduction of vacuum due to heavy air leakage.

It is evident that with the cooler taking care of the process at the knee of the curve and the main condenser hot and active throughout its depth, water cannot pass through great groups of tubes without heating, and therefore the entire bulk of the circulating water can be heated with only one passage through the tubes instead of multiple passes. The circulating water may be pumped, therefore, at low head and power consumption, with high average rate of condensation since none of the tubes is wasted, or

(Continued on page 758)

Fuel Saving in Modern Gas Producers and Industrial Furnaces

By W. B. Chapman,[1] New York, N. Y.

This paper calls attention to the wastes of fuel in the industries using gas producers and producer-gas furnaces. Both of these problems are in the field of combustion engineering.

The progress made in the last twenty-five years in gas-producer construction is emphasized by the descriptions of leading mechanical producers now in the market, together with an indication of their fuel-saving possibilities.

Attention is called to the savings made possible by using suitable accessories in the gas house.

To illustrate the possible savings in furnace operation a description is given of a distinctive type of recuperative furnace. The extension of the use of such a furnace to pulverized coal and oil would, the author states, result in similar savings.

There are about 10,000 gas producers in the United States. With the exception of the modern mechanical producer, most of these are "sick" and badly in need of a "gas doctor," and the furnaces they supply are in an equally bad way.

The producers in use are divided approximately as follows: 6500

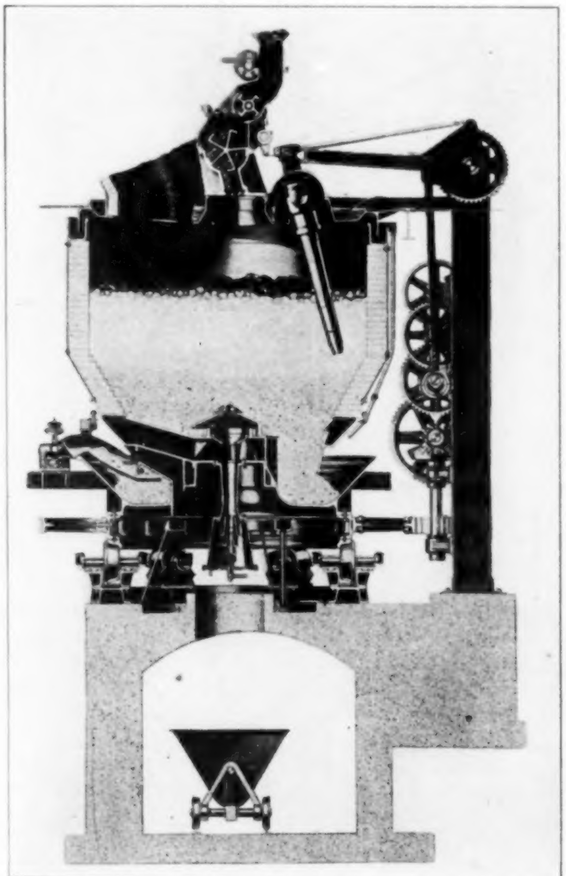

Fig. 1 Hughes Producer

in the steel industries; 1500 in the glass industries; 500 in the chemical industries; and 1500 in miscellaneous industries. Under "miscellaneous" are included the ceramic industries, lime burning and about 200 gas producers used for power.

Engineers have given much attention to the engine room, some to the boiler room, a little to industrial furnaces, and least of all to the making of raw producer gas. Hence the backward condition of the gas house.

No definite data have been compiled by the Government on the amount of coal used in gas producers, but with the assistance of such figures as are available it is estimated roughly that in the steel industries about 15,000,000 tons of bituminous coal are transformed annually into raw producer gas for use, and in the glass industries about 2,000,000 tons.

In the steel industries about the same amount of coal is used for making gas to heat furnaces as for making steam. In glass

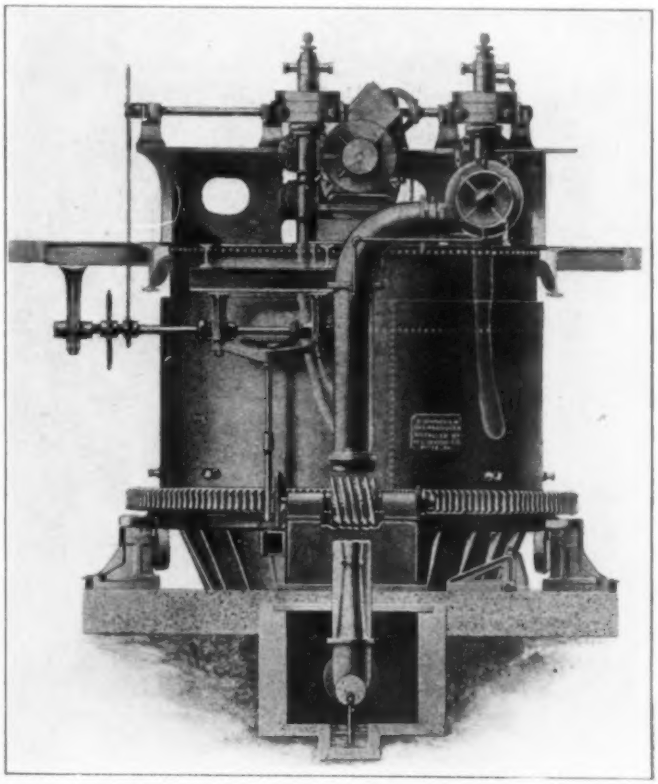

Fig. 2 R. D. Wood Producer

making three-fourths of all the fuel is used in gas producers. But wherever producer gas is used it is apt to be the most backward part of the business. A given amount of time and money, if spent on improving conditions in the gas house, will usually bring larger returns than in any other department. In most industries requiring large heating operations more trouble arises in that department than in any other part of the business.

Much progress has been made in the past 25 years in gas-producer construction. It started with the excellent work of W. B. Hughes. Progress in furnace construction, however, has lagged. The chief incentive to improvement of both producer and furnace has been high-priced labor, and the few advances made in furnace construction have been confined mostly to certain labor-saving features. Now the situation has changed; fuel saving has been put on a par with labor saving, and interest is being noted all along the line.

The Producer-Gas Process

In making producer gas there are three steps or operations: (1) Feeding the fuel; (2) agitating the fire; and (3) removing the ashes. Progress in producer construction has centered on various ways of performing these three operations automatically.

Automatic Coal Feeding, if continuous and uniform, will increase the B.t.u. in the gas about 10 per cent and will improve its uni-

[1] President, Chapman Engineering Company. Mem.Am.Soc.M.E.

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formity to such an extent that it can be burned in the furnace with a 10 per cent improvement in economy. However, the labor saving due to automatic feeding is slight, and should not be confused with the labor saved by the use of coal-handling equipment and overhead bins, always a good investment for installations of more than one producer.

Automatic Agitation, if suited to the kind of coal used, will increase the B.t.u. from 10 to 20 per cent (depending largely upon the zeal and skill with which it was formerly hand-poked) and the uniformity thus obtained will cause a corresponding saving in utilizing the gas in the furnace. The combined effect of automatic

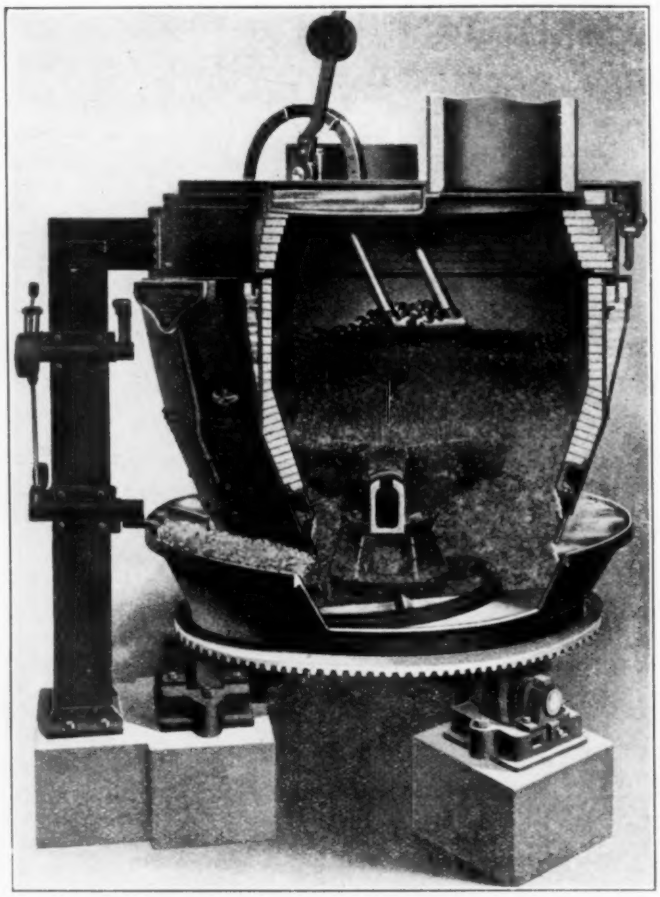

Fig. 3 Morgan Producer

feeding and automatic agitation usually makes possible a saving of 25 per cent of the fuel required for a given operation.

Automatic Ash Removal is of two kinds—intermittent and continuous discharge. The intermittent type removes the ashes once or twice in 24 hours. It is open to the objection that during the ash-removal period the fire is badly disorganized and a poor quality of gas is made for possibly half an hour. The continuous type of ash removal is entirely free from this objection. In Europe the continuous type is much in favor, although but few have been installed in this country.

The saving caused by mechanical ash removal depends largely upon the kind of device used. If the ashes are removed intermittently, and if no effective agitation accompanies the ash removal, the saving will be limited to the two or three hours' time required daily for the ash men to shovel the ashes out by hand. If, on the other hand, the ash removal is continuous and is accompanied by suitable agitation of the entire ash bed and lower portion of the fire bed, there will be a considerable saving in the labor required both for manipulating the fire and for cleaning clinkers off the walls. Moreover, the continuous type of ash removal, accompanied by ash agitation, will increase the capacity of the producer about 50 per cent and will save some fuel on account of the improvement in the quality and uniformity of the gas. Unfortunately the continuous type of ash remover, combining with effective agitation, is little known in this country, although it is the common type in use throughout Europe.

Types of Producers

Bearing in mind the foregoing three steps in making producer gas, let us now consider the types of producers in most common use in America, the Hughes, the R. D. Wood,[1] the Morgan and the Chapman. Each is an excellent machine.

To Mr. Hughes, then chief engineer of the Pencoyd Iron Works, is accorded the credit for having installed at that plant in 1897 the first successful mechanical producer in America. This machine is still in operation. As will be seen from Fig. 1, the chief feature consists in a vertical water-cooled finger hinged to the stationary top of the producer and made to oscillate between the center and the wall while the body of the producer and its contents revolve underneath. Thus, in time, the entire contents of the producer are stirred. The speed of this producer was originally one revolution in 20 min., but every few years it has been increased until now the walls make one revolution in 8 min., with considerable increase in capacity.

Since the installation of the first Hughes producer, an automatic ash-removing device has been added. It consists in a stationary bar arranged to sweep the ashes from a revolving grate. The bar

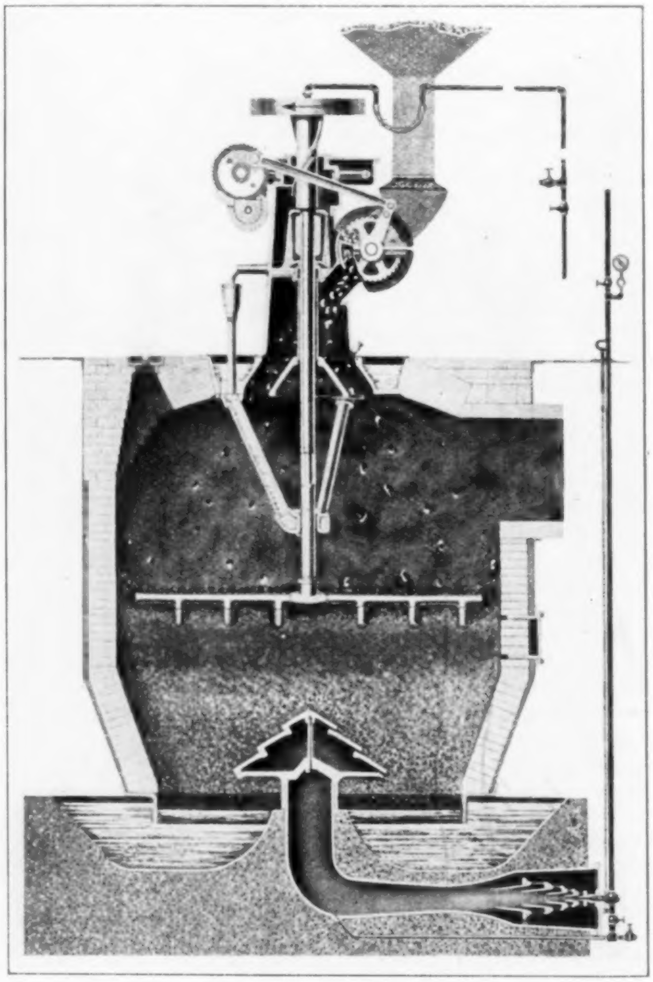

Fig. 4 Chapman Producer

is inserted once or twice every 24 hr. for a short period and then removed. No attempt is made to use the device for agitating the lower portion of the fire bed. Recently an automatic feed—in fact two automatic feeds—has been added, thus making the producer completely mechanical. The double feed gives unusually good coal distribution. This is the oldest producer on the market, and there are over 800 in operation—more than any other mechanical producer.

[1] The Wood type is manufactured by two different companies.

The R. D. Wood producer, Fig. 2, is somewhat like the Hughes, in that it uses the vertical-stirring-arm principle. There are two vertical arms, one near the center and the other near the wall. These stirring arms are bent as shown in the illustration, but instead of oscillating from center to side they revolve around their vertical axes. The walls of the producer revolve and thus the fire bed is carried past the stirring device. The coal is fed from a rotating drum located eccentrically. As the revolving fire bed comes under the feeding device fresh fuel is supplied to it. The speed of the producer is one revolution in 30 min. A steam-turbine blower is supplied in addition to the ordinary steam-jet blower. The turbine has an extra large capacity, operates quietly, and usually gives results that are more uniform than a steam-jet blower.

The ash is removed by a blade or plow attached to the lower edge of the revolving producer wall and extending down into the ash bed. The blade takes out ashes at a fixed rate, which is somewhat faster than they are made and therefore it cannot be operated quite continuously. Scoops are attached to the skirt of the revolving wall for carrying the ashes around to a suitable point for final discharge. The capacity of this producer is unusually large, owing to the facts that there are two stirring arms in place of one, and the removal of the ash is nearly continuous. Moreover, the diameter of the Wood producer is 10 ft. 6 in., instead of the usual 10 ft. This producer is particularly popular among glass manufacturers, and some remarkable records have been secured with it.

In a producer having vertical stirring fingers it is highly desirable to keep the top and bottom of the fire bed always at the same level so that the stirring fingers will always project the right distance into the fire bed for best results. If these fingers should reach too near the ashes, the air blast would break through into the recess or gap left in their wake and spoil the gas. A continuous, or at least semi-continuous, ash removal would thus seem to be necessary in order to keep approximately the same amount of ashes in the fire bed all the time and approximately the same amount of fire.

The Morgan producer, Fig. 3, like the Hughes, is 10 ft. in inside diameter and has about the same capacity. Also, like the Hughes, it is very popular in the steel trade. However, it differs radically in both the method of agitation and in the ash removal. Instead of vertical arms projecting deep into the fire bed, a horizontal arm which rides on the surface is used, it being claimed that surface agitation is quite sufficient and anything more is detrimental. The writer's experience would seem to prove that surface agitation is hardly adequate when caking coals are used. Nevertheless some very excellent results have been obtained. As will be seen from the illustration, the agitator is in the form of a swinging U-tube with the ends hinged to the stationary top of the producer. The walls and the ashpan of the producer revolve and carry the fire bed around with them. The speed has recently been increased to one revolution in twelve minutes.

The ash is removed by a spiral arm lying on the bottom of the ashpan. Ordinarily the arm revolves with the pan so that no ashes are removed. From one to three times every 24 hr. the outer end of the spiral arm is engaged and held fast, thus producing relative motion between the arm and the pan and causing the ashes to flow out rapidly. An ingenuous device provides for the automatic release of the ash arm when the producer has made a full revolution. The ashes obtained in this way are exceptionally free from carbon. After the ashes are taken out the fire bed is "broken down" by hand poking and drops from six inches to a foot.

In all gas producers that do not provide for continuous removal of the ash there is a definite *cycle of operation*, extending from one ash-removing period to the next. This is usually a 24-hr. cycle, but in some cases it is 12 or even 8 hr., and in the case of the Wood producer it is semi-continuous. At the beginning of the cycle (immediately after the ashes have been removed) the fire bed, though not changed in thickness, is located much lower down in the producer than at the end. This difference in height of the location of the fire bed in the producer from the beginning to the end of the cycle is usually about 2 ft. if the ashes are removed but once in 24 hr., but is correspondingly less when the ashes are removed more frequently. It is therefore apparent that if a producer is to be agitated uniformly it should be provided either with approximately continuous ash removal or with an agitator which automatically varies in height according to the varying height of the fire bed.

The Chapman producer, Figs. 4 and 5, is the only gas producer sold in parts. The agitator alone may be installed on any stationary producer, or the agitator in combination with the automatic feed may be installed on old or new stationary producers, or, again, a completely mechanical producer including automatic feed, agitator and ash remover may be obtained. The agitator, as will be seen from the illustrations, is in the form of a rake with water-cooled teeth. The rake revolves once in 7 min., and thus every portion of the fire is passed over every $3^1/_2$ min., which is more than twice as frequent as in any other producer. In most producers agitation depends upon the speed of the walls, which are rather cumbersome to operate rapidly.

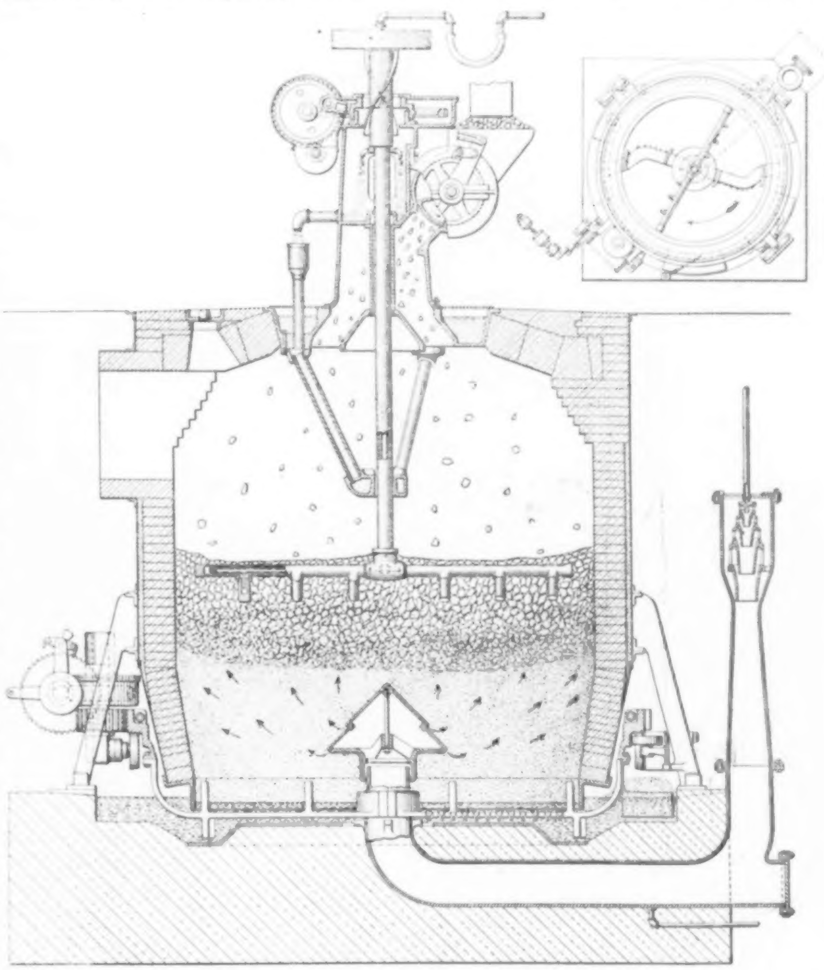

Fig. 5 Chapman Continuous Gas Producer

The agitator is driven by a patent driving head having two long spiral flanges upon which the agitator automatically "screws up" as the fire bed grows higher and "unscrews" when the height of the fire bed drops. These spiral flanges are in sliding contact with two revolving lugs which project inwardly from the hub of the driving wheel. As fresh coal is put on the fire it tends to bury the agitator beneath it. This makes the agitator turn harder through the fire bed, and immediately the torque is increased the driving head screws up to where the forces are again in balance.

If the agitator strikes a large clinker fast to the wall it screws up over it and drops down on the other side, thus avoiding any undue strain on the machinery. The action is a little like that of the Yankee screw driver.

The cross-arm of the agitator operates a few inches below the surface of the fire bed, and the fingers project down 8 in. farther. This makes the depth of the agitation about midway between the surface agitation of the Morgan and the deep agitation of the Hughes and Wood. As the fingers project forward the cross-arm immediately fills in the gaps in their wake. The out-stroking effect of the cross-arm tends to pack the fuel against the wall, which helps to prevent blowholes and clinkers.

The automatic feed drops the coal evenly over all parts of the fire bed simultaneously, and thus does not require a revolving fire bed. The object is to produce slightly better gas-making conditions than when the fuel is dropped only in one corner or sector of the producer at a time.

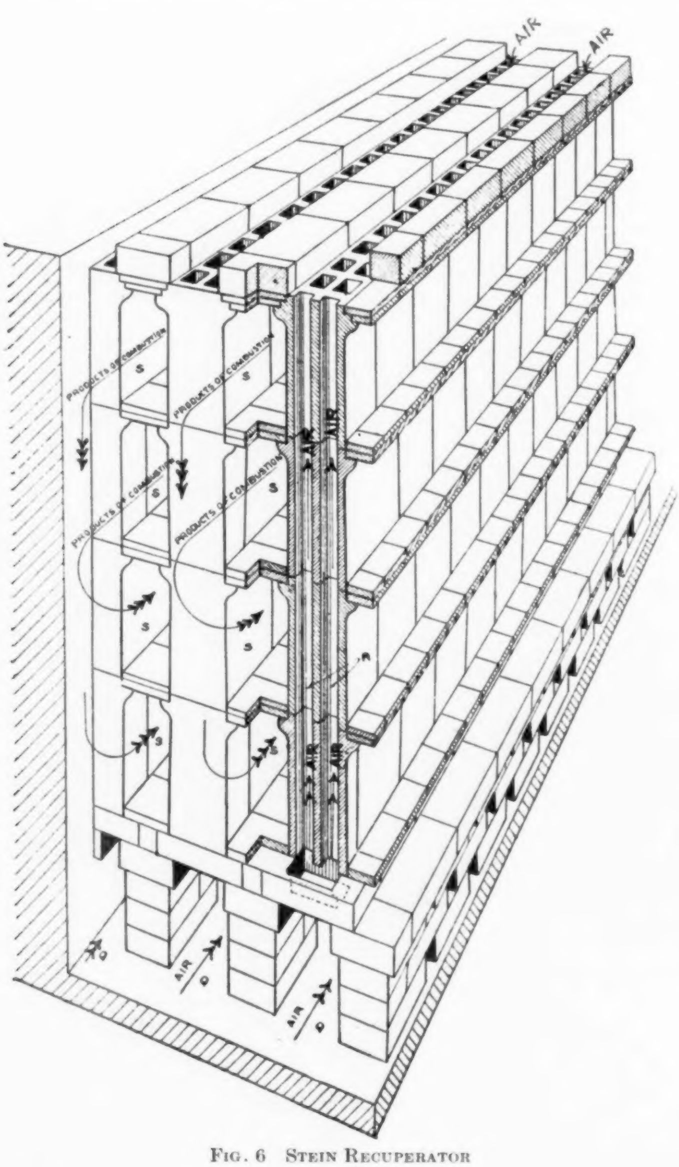

Fig. 6 Stein Recuperator

The ash-removing device operates continuously. It consists in a slowly revolving beam extending across the producer through the ashpan and driven by a gear ring which encircles the producer just above the pan, the speed being adjustable to synchronize with the rate the ashes are being made. The speed of the gear ring is adjustable from a revolution an hour to one in ten hours. After the ashes have been forced out by the beam into the outer portion of the ashpan they are picked up by scoops attached to the gear ring and carried to the point of discharge.

The Chapman producer makes use of the European idea of agitating the firebed from beneath. The ash beam is provided with fingers which project upward and impart motion both to the ashes through which they move and the fire bed resting on the ashes. This is to help in preventing blowholes and clinkers and to increase the capacity.

The size of this producer is 11 ft. inside diameter—the largest made—and the capacity is increased accordingly.

Savings With Mechanical Producers

With the usual more or less unskilled and indifferent handling, any of the four American mechanical producers can make a gas averaging 150 B.t.u. (low values) instead of the customary 125 B.t.u. obtained in hand-poked producers if operated with zeal. With skilled handling the best mechanical producers will average from 160 to 175 B.t.u., provided the coal is fair and the rate of gasification does not exceed 25 or 30 lb. per sq. ft. per hr., which is about twice the capacity of hand-operated producers.

A Duff producer, operating originally at 10 tons a day and making gas naving 125 B.t.u., was fitted with a Chapman agitator and automatic feed, and at 36 tons a day gave an average of 163 B.t.u. Similarly, a Von Kerpley producer, the most popular mechanical type in Europe, gasifying 20 lb. per sq. ft. per hr., making about 135-B.t.u. gas, was equipped with Chapman agitator and automatic feed and changed to 34 lb. gasified per sq. ft. per hr. and 178 B.t.u. This was maintained without difficulty and without any hand poking.

The best modern producers properly operated will usually save about 25 per cent of the coal and an equal amount of labor. These savings should amount to the total cost of the installation in from one to four years.

The temperature in a gas producer is highest at the bottom of the fire, and the thicker the fire the cooler the top. The temperature at the bottom should be as high as the fuel will stand without running too much risk of melting the ash. The melting point of the ash in all the good Pittsburgh gas coals is well above 2500 deg. fahr., and the melting point of the ash in Illinois coals is about 300 deg. lower. The temperature at the top of the firebed should be as low as will permit the gas to be conducted to the place of use without forming objectionable tar deposits, and also as low as possible without making the top too sticky and difficult to blow through. Usually a "top temperature" of 1000 deg. fahr. is about right, but if the gas is to pass through a water-cooled reversing valve located some distance away 1200 deg. would be better. A "hot top" destroys some of the richest gases and thus wastes fuel. More fuel is wasted in a producer from running with a hot top, i.e., over 1300 deg., than from any other cause.

A considerable saving of coal can be brought about by using suitable accessories in the gas house. The most important of these is a pressure regulator, which, when the pressure in the gas main falls, blows the producer harder and makes more gas, and vice versa. A temperature recorder is also of great assistance. A few additional regulating and recording devices are needed if one is to obtain the highest efficiency in daily operation.

The Furnace Part of the Problem

But, *gasifying the fuel is only half the problem of conserving it.* The other half lies in its utilization in the furnace. The two halves of the problem are inseparable. They are both the field of the combustion engineer. Space is too limited to take up more than one kind of furnace—the kind that holds the most promise for fuel conservation and the kind that until the last decade has largely been a failure—the recuperative furnace.

A recuperative furnace is never "reversed" and, except in rare instances, only the air is preheated. It costs much less to build and to repair, is easier to operate and gives practically the same efficiency as the expensive and cumbersome regenerative furnace.

The field of application for the recuperative furnace is very broad and it can be used effectively in both large and small operations, for furnace temperatures as high as 2700 and as low as 1400 deg. About the only uses to which it is not suited to are for operations which periodically require a large overload such as the open-hearth process and large forgings over 32 in. in diameter, also for large glass melting tanks. For almost all other purposes the recuperative furnace can be used with great economy.

In many operations where the air is not now preheated it will be found that from 20 to 40 per cent of the fuel can be saved by using a good recuperator—one that preheats the air to within 500 deg. fahr. of the temperature of the furnace.

The Stein recuperator is shown in Fig. 6 and the Stein recuperative furnace in Fig. 7. The furnace is the one most favored in Europe, where, as might be expected, the necessity for fuel economy has caused engineers to give more attention to the problems of combustion than in this country. The recuperator of this furnace preheats the air to within less than 500 deg. fahr. of the temperature of the gases leaving the furnace and is as efficient after six years of operation as when first installed.

Another distinctive feature of this furnace is that the gas and air are mixed together a few feet before they enter the furnace but are not given room enough to burn until they reach the combustion chamber. A high heat is then obtained immediately.

The recuperative tile in this furnace is set to form horizontal passages for the spent gases, the joints being protected by a double seal. Each tile is provided with four small vertical passages for the air. These passages form straight chimneys about 6 ft. high with no

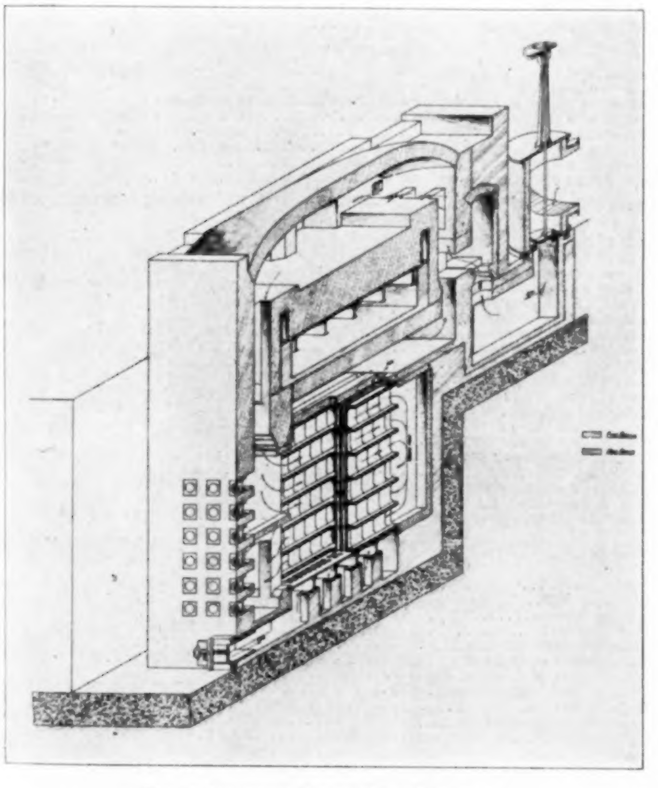

FIG. 7 CHAPMAN-STEIN FORGE FURNACE

offsets or turns to hinder the accelerating speed of the rising column of air. The energy of velocity of the air thus attained is transformed on entering the furnace into the energy of pressure. The furnace is thus automatically operated under a slight pressure without requiring the usual blower for the air. The saving of a blower and the power to operate it, however, is not so much of a gain as the fact that the air in the recuperator is not under pressure (from a blower) but under suction caused by the chimney effect of the vertical passages, and thus the suction of the air inside the tile balances the suction of the spent gases in the passages between the tile. There is therefore no leakage—in fact no cause for leakage—from the air passages to the gas passages, which has been the bane of the recuperative furnace heretofore.

To give one example, a furnace of this description installed in this country nine months ago is now performing a certain heating operation which formerly required 550 gal. of oil a day for 350 gal., a saving of 36 per cent. The saving in oil for the first year will more than pay for the cost of the furnace.

LARGE FUEL SAVINGS POSSIBLE

It is not the purpose of this paper to dwell on pulverized coal or oil as fuel, but 20 to 40 per cent of these fuels might be saved if air for combustion were properly preheated from the waste gases by a suitable recuperator.

In view of the facts as outlined in this paper we trust that many will agree with us that from 3,000,000 to 4,000,000 tons of bituminous coal could be saved annually by better furnaces and furnace operation, and better producers and producer operation. May we therefore suggest that our Society in the future take suitable action in recognition of the situation herein set forth.

In closing the author wishes to acknowledge the kind coöperation of the Morgan, Wood, and Hughes companies who have supplied the illustrations of their producers and also some of the information contained herein.

APPENDIX 1

As there are more Duff producers in use in the United States than any other type of hand-poked producer, the following test made by the engineers at one of the largest steel works will be of special inter st.

TABLE 1 TEST OF DUFF-BRADLEY PRODUCER WITH NEW BLOWERS AND CHAPMAN AUTOMATIC FEED FLOATING AGITATOR.[1]

ANALYSIS OF SEVEN-HOUR CONTINUOUS SAMPLE OF GAS

Rate of gasification per 24 hr. = 37.36 tons.
Rate of gasification per hr. per sq. ft. = 36 lb.

CO_2 per cent	C_nH_{2n} per cent	O_2 per cent	CO per cent	CH_4 per cent	H_2 per cent	N_2 per cent	B.t.u.	Steam lb.
4	1.4	0.2	26.8	3.0	10.4	54.2	163	52

Calorific power of gas per min	552,750 B.t.u.
Sensible heat of gas per min	94,100 B.t.u.
Total useful heat of gas per min	646,850 B.t.u.
Average coal fed per hr., lb. by weight	3114
Average coal fed per hr., lb. calculated from above analysis	3081
Difference, lb	33

EXTERNAL HEAT BALANCE

Dr.	B.t.u.	Per cent	Cr.	B.t.u.	Per cent
B.t.u. per lb. coal	13,039.0	97.5	Calculated power of gas	10,660.0	79.7
B.t.u. steam and air	336.5	2.5	Sensible heat of gas	1,803.0	13.5
			Loss unburnt coal	146.5	1.1
			Other loss (radiation, etc.)	716.0	5.7
	13,375.5	100		13,375.5	100

Total losses, 6.8 per cent.
Efficiency of producer, 93.2 per cent.
Standard gas temperature of 62 deg. fahr. used.
No hand poking was done during test and no clinkers were made.
In calculating B.t.u., U. S. Steel Corpn. lower values are used.
West Virginia coal used carrying 37 per cent volatiles.

[1]Former capacity of this producer was 10 tons in 24 hr. and the gas averaged 125 B.t.u. Producer was rebuilt to 10 ft. 6 in. diameter.

APPENDIX 2

As there are more Von Kerpley producers in Europe than any other mechanical type, we give the following test. The Kerpley producer, like the other European producers, has continuous ash removal and continuous agitation of the ash bed and lower part of the fire bed, and there is no agitation of the upper part of the fire bed and no automatic feed. Before installing the Chapman automatic feed and floating agitator the capacity was 12 cwt. per hour and in spite of an enormous amount of hand poking the producer was usually full of clinkers. After the new equipment was added the capacity was increased considerably over 50 per cent, no hand poking was required and no clinkers were made. The works engineer estimated that the saving in labor alone was sufficient to pay for the equipment in nine months. The B.t.u. in the gas was increased about 30 per cent.

TABLE 2 TEST OF VON KERPLEY PRODUCER, WITH CHAPMAN AGITATOR AND AUTOMATIC FEED

Test on 9 ft. 7 in. inside diameter Von Kerpley gas producer fitted with a Chap nan agitator with automatic feed.
Duration of test, 49½ hr.
Average analysis of gas samples taken hourly:

CO_2	O_2	CO	C_2H_4	H_2	CH_4	N_2
4.74	0.30	24.6	0.30	12.80	5.26	52.00

Total combustibles, 42.90 per cent.
Average coal fed per hour, 2408 lb.
Calorific value of gas, 178 B.t.u. per cu. ft.
Net English heat values used: CO—345, H_2—290, CH_4—975, C_2H_4—1590.

HEAT BALANCE

Dr.	B.t.u.	Per cent	Cr.	B.t.u.	Per cent
B.t.u. per lb. coal	13,906.0	97.2	Calculated power of gas	11,498.9	80.34
Sensible heat of coal	13.2	.09	Sensible heat power	1,925.0	13.50
Sensible heat of steam	328.8	2.3	Loss in unburnt coal	46.3	.32
Sensible heat of air	54.0	.41	Sensible heat of ash	1.8	.01
			Do. of water passed through agitator	55.46	.38
			Other losses (radiation etc.)	774.54	5.45
	14,302	100		14,302	100

Total losses, 6.16 per cent.
Efficiency of producer, 93.84 per cent.
Producer equipped with Chapman 5-stage blower with 7/16 in. nozzle.
Coal used: Florence beans 17.62 per cent, Florence nuts 30.65 per cent, Stafford cobbles 20.73 per cent, Florence cobbles 31.00 per cent.
Coal gasified per sq. ft. per hr. 34.01 lb.
Steam used, 0.278 lb. per lb. of coal.
Gas per lb. of coal, 64.6 cu ft.

Boiler-Plant Efficiency

By VICTOR J. AZBE,[1] ST. LOUIS, MO.

The usual wastes in boiler plants are brought out strikingly by means of tables and curves of boiler performance compiled from a large number of observations.

The object of this paper is to show to what extent these wastes are preventable or can be made to balance each other, and to recommend a standard for boiler operation toward which designers and operators of boilers may aim.

The author considers that there still remains an immense field for experimental research to obtain the necessary data for boiler construction. The requirements of the ideal boiler installation of today are summarized.

THE degree of waste in boiler plants is not generally realized and there is a tendency to judge conditions by a few of the better plants where improvements have been made and whose results are considered as representative of the average-run boiler plants.

Tables 1 and 2 show two boiler tests made under ordinary operating conditions, one on a hand- and one on a stoker-fired boiler. During these tests care was taken that actual operating methods were pursued. The results are very bad but representative of most smaller and some of the larger installations.

Table 3 gives the results of three boiler tests, all made on the same boiler some time apart. The boiler was of the B. & W. type, but poorly set, with a limited combustion chamber of only 0.87 cu. ft. per rated boiler hp. The stoker in use was of the old Jones type.

During Test A the aim was to maintain the same operating conditions as existed before any improvements were made; the result was an efficiency of 56 per cent and boiler rating of 102 per cent. After this first test improvements were begun, without, however, altering the stoker or increasing the combustion space.

After about six months, results were obtained as represented by Test B in Table 2; the efficiency was increased to 68.5 per cent and capacity to 140 per cent of rating. The results were not as yet considered satisfactory and efforts for further improvement were made. In all about 30 boiler tests were run under different conditions and with different fuel and one of the last tests is represented by Test C in Table 3. This last test is very remarkable in several respects, but is correct. In fact, the results are checked by other tests giving equal or even slightly better results.

The remarkable features of the results of this test are as follows:

1. High boiler efficiency with a relatively inefficient installation and relatively poor coal
2. Complete combustion with high volatile coal and a combustion space of only 0.47 cu. ft. per developed boiler hp. or 0.11 cu. ft. per lb. of coal including the space occupied by the coal
3. A draft drop through a 16-section, 9-tube (each 16 ft. long) B. & W. boiler of only 0.1 in. at 85 per cent overload
4. A flue-gas temperature of 532 deg. fahr. at 85 per cent overload in spite of the limited combustion space and flame extension to almost the end of the first pass
5. An improvement of 39.5 per cent in economy over that of Test A
6. An improvement of 81.4 per cent in capacity over that of Test A, in spite of the fact that during the first test maximum boiler rating was aimed at. Other examples could be enumerated of great improvements being made.

Standard of Economy

The writer considers 90 per cent efficiency as the standard of economy attainable under favorable conditions, this 90 per cent representing boiler and economizer without taking auxiliary power into consideration, however. The requirements for this efficiency are rather severe and with 12,000 B.t.u. bituminous coal, 15 per cent excess air would have to be used, flue-gas temperature would have to be no more than 250 deg. fahr., combustion complete and no carbon in the ash. These requirements are listed in Table 4.

TABLE 1 TEST ON HAND-FIRED BOILER REPRESENTING VERY UNECONOMICAL CONDITIONS

Date of test	Dec. 2, 1920
Type of boiler	B & W
Grate	Shaking
Kind of coal	Illinois screenings
Steam pressure, gage, lb	135.6
Temperature of feedwater, deg. fahr	205.0
Temperature of flue gas, deg. fahr	568.4
Draft at back damper, in	0.48
Draft over the fire, in	0.24
Carbon dioxide, per cent	5.68
Quality of steam, per cent	98.5
Rated boiler hp	150.0
Per cent of rated capacity developed	105.9
Evaporation, equivalent, coal as fired, lb	4.91
Evaporation, equivalent, coal dry, lb	5.51
Calorific value of coal, dry basis, B.t.u	11510
Coal analysis, per cent: Moisture	10.9
Ash	15.8
Volatile matter	35.2
Fixed carbon	38.1
Carbon in ash, per cent	24.4
Heat Balance	**Per cent**
Heat absorbed by the boiler	45.31
Loss due evaporation of moisture in coal	1.31
Loss from vapor of hydrogen combustion	5.41
Loss in dry flue gas	28.21
Loss due to carbon monoxide	4.24
Loss due to combustible in ash	5.40
Loss due to heating of moisture in air	0.30
Loss due to radiation, hydrogen, hydrocarbon, etc	9.22

TABLE 2 TEST ON STOKER-FIRED BOILER REPRESENTING VERY UNECONOMICAL CONDITIONS

Date of test	Feb. 23, 1917
Type of boiler	Heine
Type of grate	Detroit
Kind of coal	Pocahontas nut & slack
Steam-pressure, gage, lb	138
Temperature of feedwater, deg. fahr	152
Temperature of flue gas, deg. fahr	761
Draft at back damper, in	0.98
Draft over the fire, in	0.38
Carbon dioxide, per cent	8.1
Coal burned, lb	14700
Water evaporated, lb	96480
Evaporation (actual), lb	6.56
Evaporation (equivalent), lb	7.25
Boiler hp. developed per hr., lb	386.6
Boiler rating, hp	328
Per cent of rating developed	118
Heat value of fuel, B.t.u	13950
Boiler efficiency, per cent	50.4

TABLE 3 BOILER TESTS REPRESENTING IMPROVEMENT OF BOILER PERFORMANCE

Test[1]	A	B	C
Type of boiler		B & W	
Type of stoker		Jones	
Kind of coal		Illinois screenings	
Steam pressure, gage, lb	130	127	129
Temperature of feedwater, deg. fahr	180.6	187.0	176.8
Temperature of flue gas, deg. fahr	612	533	532
Draft at back damper, in	0.57	0.34	0.11
Draft on fire, in	0.45	0.24	0.01
Forced-draft pressure, in	3.00	3.52	4.04
Carbon dioxide, per cent	7.6	13.3	14.0
Quality of steam, per cent	0.991	0.991	0.990
Rated boiler hp	269	269	269
Per cent of rated capacity developed	102	140	185
Evaporation, equivalant, coal as fired, lb	6.14	8.19	8.43
Evaporation, equivalent, coal dry, lb	6.95	9.05	9.55
Calorific value of coal, dry basis, B.t.u	12080	12850	11864
Coal analysis, per cent: Moisture	11.7	9.9	11.7
Ash	13.4	8.9	12.5
Volatile matter	31.0	32.2	32.5
Fixed carbon	43.9	49.5	43.3
Carbon in ash, per cent	16.7	19.4	17.2
Efficiency of boiler furnace and grate, per cent	56.0	68.5	78.1
Improvement in economy over Test A, per cent	....	22.3	39.5
Increase in capacity over Test A, per cent	....	31.4	81.4

[1] Test A indicates conditions when no effort toward economy was made, while Tests B and C show gradual improvement under an economy campaign. In all three cases maximum possible capacity was striven for.

TABLE 4 IDEAL BOILER AND FURNACE PERFORMANCE

Kind of fuel	Bituminous coal
Heat value of fuel, B.t.u. per lb	12000
Moisture of fuel, per cent	10
Hydrogen in fuel, per cent	3.5
Theoretical air per lb., lb	8.98
Excess air, per cent	15
Actual air per lb., lb	10.33
Flue-gas temperature, deg. fahr	220
Heat Balance	**Per cent**
Loss due to dry chimney gas	3.15
Loss due to moisture from H_2O	2.85
Loss due to moisture in coal and air	1.00
Loss due to carbon in ash	1.00
Loss due to incomplete combustion	0.00
Loss due to radiation and conduction	2.00
Total loss	10.00
Boiler efficiency	90.00

[1] Consulting Engineer. Assoc-Mem. Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

This ideal or 90 per cent boiler and furnace efficiency has been attained only once, and then by Henry Kreisinger and John Blizard at the Lakeside Station of the Milwaukee Electric Railway & Light Co.

Fuels

With a suitable installation, almost as high an efficiency will be obtained with low- as with high-grade fuels. The only real obstacle to this is the tendency toward a greater ashpit loss with lower-grade fuels.

As a rule low-grade fuel should be burned close to the mines and higher-grade fuel transported. Freight to distant points should not be compared on a tonnage but on a heat-value basis. The cost of fuel also should be based on heat value rather than on the weight.

Combustion

There are several reasons why properly proportioned furnaces with ample combustion space are necessary, the most important being the prevention of escape of unburned gas and formation of

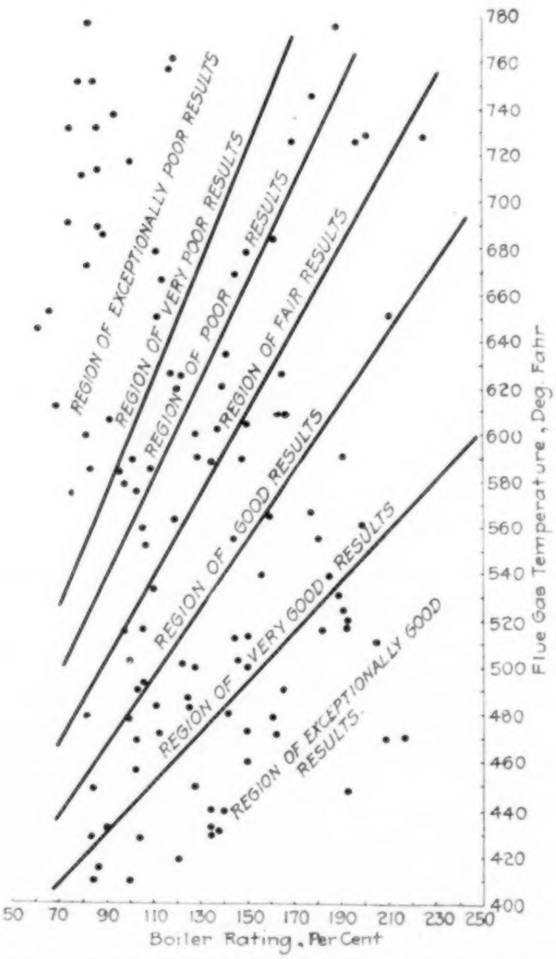

Fig. 1 Flue-Gas Temperatures Representative of Good and Bad Results

soot, the possibility of operating with the least amount of excess air without incomplete combustion, and the prevention of flame entrance among the boiler flues. This last is necessary to obtain low flue-gas temperatures and will be considered under that head.

Furnace volumes vary from 1 cu. ft. per lb. of coal burned per hr. down to less than 0.1 cu. ft. in some cases. The lower amounts, of course, do not represent the entire combustion space because combustion under such conditions extends among the tubes, at times for a considerable distance, but this is not what is to be desired. The larger amounts are used with powdered fuel and are necessary because the solid particles burning are relatively large and require a larger combustion chamber for their gasification and combustion than is the case when gasification, and to a certain extent mixing with air, takes place on a grate.

The aim is to have the gas completely burned and no flame entering the first tube pass. To accomplish this, more than mere furnace volume is necessary. There are such things as effective and ineffective combustion space.

Excess Air

The largest preventable loss in boiler plants is that caused by excess air. Determination of this loss by the measure of the CO_2 and flue-gas temperature has achieved considerable popularity.

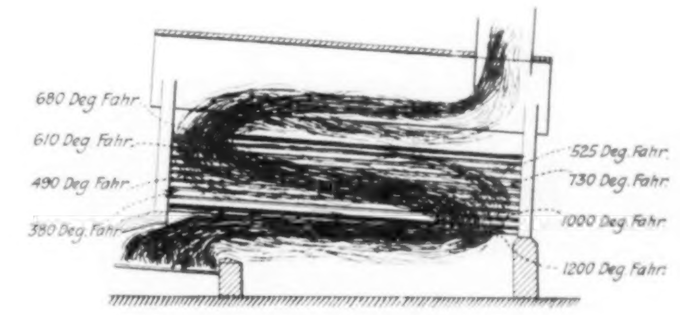

Fig. 2 Unequal Gas-Flow Distribution Through a Boiler

Where such popularity has been attained, the trouble is, however, that quite generally there is satisfaction if the fuel is burned with 100 per cent excess air, and even in well-operated plants no better results are obtained on the average. This is because of the tendency of many an engineer to assume statements as correct without sufficient consideration. With the large combustion chambers coming in vogue nowadays the old assumption that 10 or 12 per cent CO_2 is all that pays becomes obsolete. If we design our furnaces so that flame terminates before gas enters the tubes or soon thereafter and with the boiler heating surface so exposed that the maximum amount of heat is radiated to it, then the standard of good performance is the burning of the fuel with 15 or at the very most 25 per cent of excess air, and the CO_2 maintained should be around 16 per cent.

The point at which excess air enters in very important and should be given greater prominence when boiler-test data are recorded. At present during a test we tend to be primarily concerned with what occurs on the ends; that is, in the furnace and uptake, and few, if any, observations are taken and records made of what occurs between these points. Such items as point of flame termination, relative amount of oxygen, carbon dioxide percentage (which is a true measure of excess air), and temperature drop at various points through the settings, should be carefully recorded and interpreted; then it will be possible to really compare the performance of one boiler with another, which can hardly be properly accomplished with the data now commonly obtained.

A somewhat overlooked but also very important factor affecting boiler plant economy is "constancy." The percentage of CO_2 may fluctuate during the day from high to low, but if for the whole day a 10 per cent average is taken, it will be found that for a number of reasons the efficiency will not be nearly so good as when 10 per cent of CO_2 is constantly maintained. Therefore the average CO_2 is an improper measure of the loss, but at the same time is a good indicator of improper conditions.

Heat Transfer and Flue-Gas Temperature

The temperature of the escaping products of combustion determines fuel loss to a great extent, but what is low and what is high flue-gas temperature? The lack of a suitable measure and standard has in the past prevented proper comparison of results and has also caused a certain lack of incentive for improvement. The writer, in his effort to evolve a measure, has drawn Fig. 1 based on 150 different boiler tests. Each dot represents the average flue-gas temperature at the average rating developed in each test. The space is divided into sections varying from exceptionally good to exceptionally bad results, with the slope of the line following as closely as possible the increase of flue-gas temperature with the increase of boiler output of a number of boiler-test series.

To absorb the heat, it is necessary to bring the gas in contact with the heating surface. This some boilers do imperfectly. If the surface is clean everything depends upon gas velocity and distribution. Fig. 2 shows what happens under certain conditions. In the dead spaces temperatures as low as 380 deg. fahr. were recorded when the flue-gas temperature was 680 deg. fahr. The gas has the tendency to take the shortest cut, a great deal like a stream of water; in fact, much might be learned from the study of water stream flow which could be applied very profitably to boiler-pass design.

Fig. 3 was drawn as an effort to show how boiler-heat transfer varies according to different influencing factors. This chart is interesting from many angles and while not exactly correct for all conditions, it is sufficiently so to permit its use The chart is

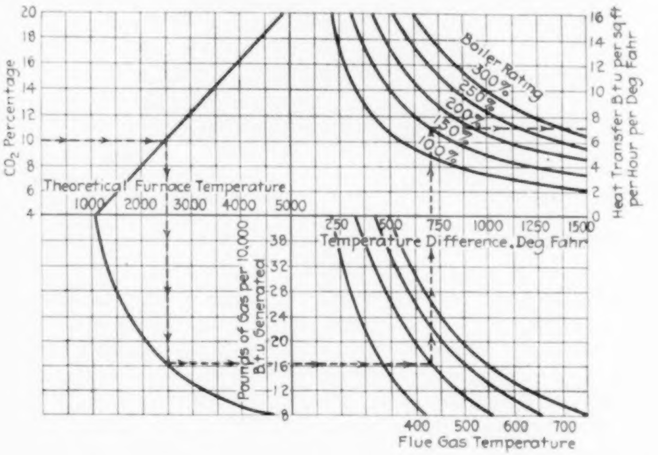

Fig. 3 Boiler Heat-Transfer Variation Under Different Conditions

Based on 365 deg. fahr. steam temperature.

based on the theory that from the actual heat-transfer standpoint we are not concerned with what the furnace temperature is, but only with the maximum theoretical temperature that would have existed had there been no absorption of heat in the furnace. If the boiler absorbed no heat from the furnace, the theoretical temperature corresponding to CO_2 would be obtained very nearly. According to this theory, if CO_2, flue-gas temperature, and rating at which boiler is operated are known, heat transfer can be determined with the aid of the chart.

Fig. 4 demonstrates that with 140 lb. boiler pressure, from 14 to 25 per cent of the total heat used to generate steam is required just to heat the feedwater 350 deg. fahr. It also shows how the necessary boiler and economizer surface varies with different temperatures of feedwater and that the total boiler and economizer surface is less than the necesary surface of the boiler only without economizer. For maximum economy, counter-current heat-flow effect must be employed in boiler plants.

Economizers pay under almost any conditions if they are installed correctly, especially if we take into consideration that they replace more than their own amount of boiler surface. It should be general practice to install smaller boilers which may be forced to greater overloads and the consequently high flue-gas temperatures reduced in economizers. Water should always enter boilers at above 325 deg. fahr. In fact, it is the approach of feedwater temperature to steam temperature in the boiler that is a measure of fuel loss resulting from not employing at all or not to full enough extent the principle of counter-current heat flow. Fig. 5 applies when there is sufficient heat in the flue gas to heat the water to the temperature of the steam, giving the fuel loss for whatever temperature of water enters the boiler. With this chart, it is possible to tell not only what good a certain economizer installation accomplishes but also what good it does not accomplish.

Boiler Capacity

When boiler capacity is increased by the burning of more fuel, the following either does or may occur:

1 Temperature in combustion chamber increases
2 Temperature of gas throughout boiler setting increases
3 Temperature difference between water in boiler and gas surrounding tubes and drums increases
4 Gas velocity increases
5 Heat absorption by radiation increases owing to higher furnace temperature
6 Heat absorption by convection increases owing to higher gas velocity and higher temperature difference
7 Flue-gas temperature increases
8 Dead spaces become more active
9 Incomplete combustion increases

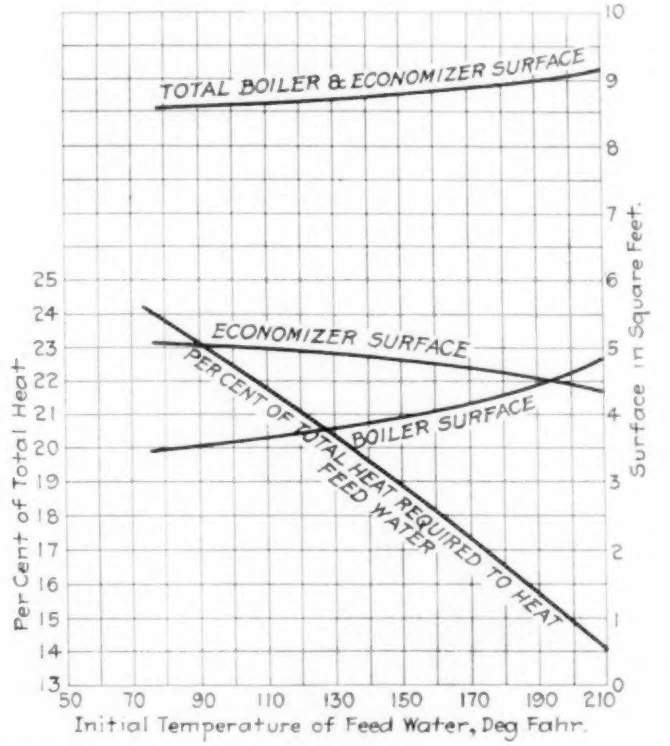

Fig. 4 Heat Required to Raise Feedwater to Temperature of 350 Deg. Fahr.

Based on economizer heat transfer of 3 B.t.u. per sq. ft. per hr. per deg. fahr.

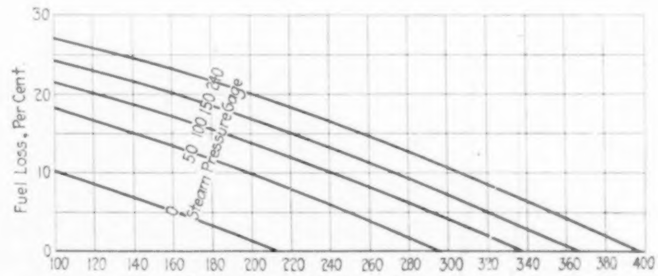

Fig. 5 Fuel Loss When Water Enters Boiler Below Steam Temperature

This figure applies only when water could be preheated by waste heat.

10 Fuel loss resulting from air in leakage and radiation expressed as a percentage of total decreases
11 Excess air decreases
12 Fireman's attention usually increases
13 Return received from investment increases.

There are several factors in this list that counteract each other, some increasing and others reducing efficiency, but as a balance, within limitations, increased boiler capacity is more economical, especially when the installation is correctly made.

It is the writer's experience that the very large majority of plants possess and operate too many boilers, at times twice as many as necessary. The cry is, "Give us plenty of boilers," and the result is waste in investment and waste in operation.

Since high boiler efficiency at low ratings is more difficult to obtain than at high ratings, it follows that owing to this and also for

(Continued on page 726)

Fuel Saving in Relation to Capital Necessary

Investigation Shows Economy Resulting From Use of Efficiency Equipment—Concrete Illustrations Given in Support of the Theory Discussed

By JOSEPH HARRINGTON,[1] CHICAGO, ILL.

SOMETHING definite and reliable in the way of information for the enlightenment and guidance of the prospective investor in efficiency equipment seems to be needed, and the object of this paper is to provide evidence to support the rather general understanding that it pays to economize. The author's original opinion was that there would be no difficulty in obtaining an abundance of first-hand information from engineers and owners who have recently installed efficiency equipment. These men invariably express satisfaction with the outcome of their endeavors, and it was thought that a compilation of such evidence would be the best possible manner of presenting this subject to the public.

In furtherance of this idea, numerous letters were written to consulting engineers, chief engineers of power plants, and owners, stating the desire of the author to secure such data. In all cases, with about three exceptions, the replies were similar, and to the effect that, while they had done this class of work, they had no records or data on which to base any figures, and they were therefore unable to provide the information requested. This in itself seems to be a fitting subject for serious thought.

Engineers in general are supposed to work along lines of precision and not guesswork, and it seems rather like an unfavorable commentary on the profession, as a whole, to state that less than five per cent of those corresponded with were able to furnish any data at all. It seems necessary, therefore, to draw upon the experience of the few having such data and let these specific instances form the starting point for what is hoped will develop into a strong body of testimony in favor of efficient methods.

Let me first present a theoretical discussion which forms, in all cases, the nucleus of the whole matter. Consider a unit of 500 hp. to be operated at 200 per cent of rating over a 10-hr. manufacturing period with coal used for starting and banking, which brings up the total coal to the equivalent of 12 hr. at double rating. This then requires 12,000 boiler hp-hr. per day, which, at 4 lb. per hp-hr., amounts to 48,000 lb., or 24 tons of coal. Now, assume that the more efficient equipment will either utilize an equal tonnage of a grade of coal costing one dollar less per ton, or by an increase in efficiency reduce the amount of coal actually used by an amount which is the virtual equivalent of the one-dollar differential. We start, then, with either a direct decrease in coal cost or an efficiency producing a differential or saving of one dollar per ton. Twenty-four tons at one dollar would provide a net saving of \$24 per day.

Now, the investment necessary to save this amount, we will say, is made up as follows:

One mechanical stoker	\$5000
Fans and installation cost in excess of equivalent hand-fired setting	2000
Total	\$7000

This amount of \$7000 divided by 24, gives 292 days as the time required for completely recovering the initial investment. This is approximately the number of working days in one year, so that in this case, it could be stated that the investment provided a return of 100 per cent per annum. Should there be a greater or less differential in the price of coal or in the efficiency, this figure must be modified accordingly, or if there is a greater cost initially, the returns would be correspondingly diminished; but assuming that this is substantially correct, the dividends are of such magnitude as to overshadow any other form of investment other than finding the money or striking oil. It can be reduced to one-half or one-third of this figure, and still loom up as a phenomenal return for any concern, however prosperous. It is more than improbable that any such return can be secured by investing the same amount of money in equipment directly providing the output of the institution in question.

To support this by specific evidence, the author presents a few concrete illustrations. The power plant of the Waterloo, Cedar Falls and Northern Railway Company was overhauled in the fall of 1913, and the author followed this installation through for some two years thereafter, the results being published in the August

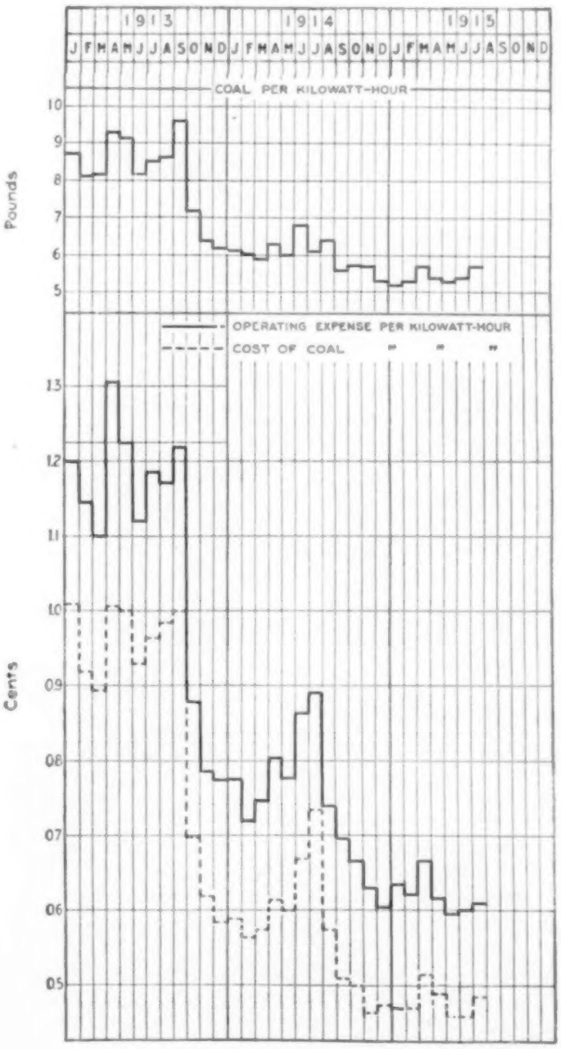

Fig. 1 Effect of Campaign to Cut Coal Cost

22, 1916, issue of *Power*. Two of the resulting curves are shown in Fig. 1. In this case there were four 500-hp. boilers installed, replacing older water-tube boilers which were also fired with the same make of stoker. With the same stoker, the same fuel, and similar boilers, the savings may very definitely be attributed to the greater efficiency secured by the then more modern setting. Not only was the furnace better proportioned and much more ample, but efficiency equipment was installed, such as gas-analysis recorders, draft gages, recording thermometers, feedwater heaters, and coal-weighing equipment. A simple system was developed for watching the indications of these instruments and drawing therefrom the logical deductions. In this particular instance, the new equipment actually paid for itself in a little over a year's time. It will be

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For presentation at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. Copies of the paper may be obtained gratis upon application. All papers are subject to revision.

observed that the coal cost per kw-hr. was just about cut in two.

During the summer of 1919 the Armour Institute of Technology made a change in their mechanical stokers from the old-style chain grate to the new traveling grate, boiler and other conditions remaining exactly the same. The modern stoker had a better grate ratio (70 sq. ft. grate surface as against 90 sq. ft.) and was designed to be more efficient at the lower ratings which occurred during the major portion of the year. Only for about two months in the year was the boiler worked up to anywhere near its capacity. Natural draft was used throughout this period—chimney 175 ft. high. The average pressure was 100 lb. gage and the average feedwater 198 deg. fahr. The remarkable result of this change is best shown in the curves in Fig. 2, furnished by Professor Gebhardt, and in the accompanying data in Table 1. Owing to the fact that no change was made in this case other than the stokers, we can safely attribute the improvement to the improvement in the stoker.

Figuring on the basis of Carterville, Ill., No. 3 washed nut coal at \$5.67 per ton delivered to the boiler-room floor, an annual gross saving of \$1553.58 was realized on the total saving of 274 tons of coal. The average cost of repairs to date is \$50. The approximate price of the new stoker was \$3500 and the installation cost \$1000, making a total of \$4500. The return on the investment is therefore 33.3 per cent.

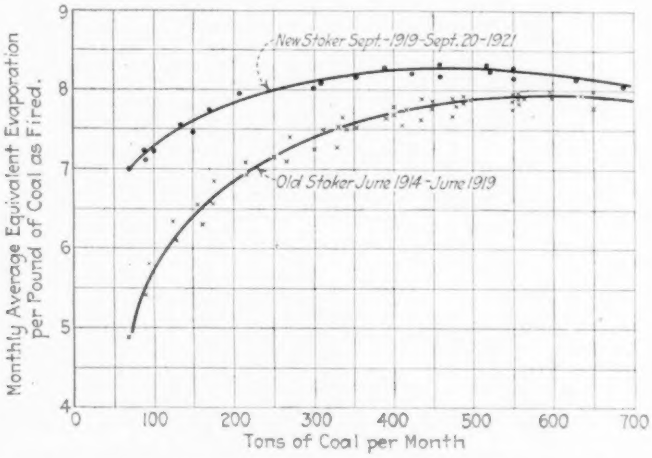

Fig. 2 Average Monthly Evaporation, 350-hp. Stirling Boiler, Armour Institute of Technology, Chicago

TABLE 1 SAVINGS OBTAINED BY USE OF NEW STOKER

	Average Evaporation		Saving in Coal		
	Old Stoker[1] A	New Stoker[2] B	Tons burned New Stoker[2] C	Tons required Old Stoker D[3]	Tons Saved[2] E[4]
June-Aug.	5.5	7.2	84	110	26
Sept.	5.5	7.2	85	111	26
Oct.	7.2	8.0	248	276	28
Nov.	7.5	8.2	335	366	31
Dec.	7.8	8.3	463	493	30
Jan.	7.9	8.2	543	554	20
Feb.	7.9	8.2	529	549	20
Mar.	7.6	8.2	413	445	32
Apr.	7.2	8.0	253	282	29
May	6.9	7.9	218	250	32
			3162	3436	274

[1] June 1914 to June 1919
[2] June 1920 to June 1921
[3] $D = (C \times B) / A$
[4] $E = D - C$

A third instance of a quite different nature is exemplified by the work of Neiler, Rich & Co. at the University of Chicago during the past season. The boiler room here consists of a number of 72-in. by 18-ft. horizontal return tubular boilers, stoker-fired, and using the usual run of bituminous coal that comes into the Chicago market. Considerable difficulty was experienced in carrying the 1919–1920 load on twenty boilers. Neiler, Rich & Co. undertook to keep this plant in operating condition until a new plant could be completed, so that what was done was merely for the purpose of keeping things going until that time, and not with the idea of a permanent improvement. No attempt was made to change any of the equipment, but it was found that the draft loss due to circuitous gas passages was very great, providing insufficient furnace draft. The combustion chamber was entirely too small, so that attention was given to improving these conditions.

By a change in the brickwork surrounding the boiler, both of these improvements were accomplished. Examining the boilers, it was found that there was insufficient circulating space between the tubes; this was corrected by removing one of the center rows and several tubes at the sides, which too closely approached the shell. These changes provided circulating space for the downward and upward flow of the water.

Apart from patching up the brickwork, covering pipe lines, etc., nothing else was done; but it was found that these changes enabled the engineer to carry a somewhat increased load on fourteen boilers. The same coal was used, and the same chimney and breeching connections were retained, so that in this instance the economies are properly credited to improved boiler circulation, furnace draft, and combustion space. The coal saving is not proportional to the number of boilers used, because the better circulation in the boiler enabled higher capacities to be carried. Very accurate figures are not available in this instance, but it is beyond controversy that the cost of the improvements made will be covered by the fuel saving, within the period of two heating seasons.

BOILER-PLANT EFFICIENCY

(*Continued from page 724*)

investment reasons, boilers should be installed designed for high overloads and high and constant efficiency over a considerable capacity range. Especially in plants where load varies a great deal the boilers should be able to take the peaks; even if these peak loads are somewhat uneconomical they are to be preferred to boilers loafing the greater part of the time. As a rule good boilers, well installed, should be operated at between 150 and 200 per cent of rating, and when a peak is of short duration 300 per cent of rating is permissible. Ratings below 150 per cent should not be permitted except under unavoidable circumstances.

Features of an Ideal Boiler Installation

It may appear to some that the boiler with its appurtenances has been developed to what might be called the limiting point; this, however, is not so. There remains an immense field for experimental research to obtain the necessary data for boiler construction.

The ideal boiler installation of today should embody the following features:

1 A construction permitting counterflow where flue gas will heat the feedwater for the boiler which will enter the boiler at as nearly the steam temperature as load fluctuations will permit
2 A combustion chamber sufficiently large and effective throughout to prevent the entrance of any flame among the tubes, thus assuring complete combustion, absence of soot, and proper cooling of the gas
3 Boiler passes which will be effective throughout without dead spaces where there is no gas flow or only little, and in which the draft drop will be the minimum corresponding to gas velocity. The gas velocity will be the highest permissible by the cost of producing this velocity
4 Fuel resistance will be overcome by forced draft
5 The relative location of fire bed and boiler-heating surface is to be such that the maximum possible amount of radiant heat will be transmitted to the boiler surface consistent with complete combustion
6 Tight boiler walls properly insulated, probably an air-jacketed furnace, the air from which will be injected over the fire bed at high velocity to aid mixing effect or passed through the grate in the ordinary way
7 A stoker permitting combustion with no more than 15 to 25 per cent excess air, no more than 1.2 per cent unburned carbon in ashpit, no deposit of slag on the tubes and these conditions maintained at low and also at reasonably high ratings
8 Scale deposit in the boilers prevented by specially constructed self-cleaning boiler, external chemical treatment of feedwater, use of distilled makeup water, filtering of the water in the boiler by recirculation or by a combination of these methods.

Control of Centrifugal Casting by Calculation

By ROBERT F. WOOD, BAYONNE, N. J.[1]

In the application of various methods of centrifugal casting there arises frequently the question of the influence of speed of rotation upon the shape or characteristics of the casting. This is particularly true if the axis of rotation is not in a horizontal plane, in which case the effect of any change in speed of rotation or in inclination of the axis is immediately felt, since every such change is accompanied by a corresponding modification in the paraboloidal shape of the bore of the casting. For certain classes of work advantage is taken of this fact to produce centrifugal castings of more or less tapering shape, instead of cylindrical as ordinarily made, an instance in point being the production of cast tubes for submarine periscopes.

This paper analyzes the controlling factors, with a view first of setting down the definite mathematical relations between them, and secondly so expressing these relations as to make them useful both in the design of machines for casting and in the operation of such machines.

As a basis for this analysis there are selected several processes which have long been on record in the U. S. Patent Office, and an examination is made of the forces brought into effect when these processes are carried out. Equations and formulas are deduced which cover the general case and which can accordingly be used for the solution of any particular case; these are so arranged as to fit them for practical everyday use, and illustrations of their application are given.

CENTRIFUGAL casting, as here dealt with, concerns concentric methods or those wherein the axis of rotation lies within the casting, in a central position. As the casting operation may be carried out in a horizontal, a vertical, or an inclined position, methods of casting fall naturally into three corresponding divisions.

The simplest, oldest and commonest method of making centrifugal castings, and the one which produces by far the greatest tonnage, is with the axis of rotation lying in a horizontal plane. The fluid material, such as molten metal, is introduced into a horizontally mounted rotating mold, over the interior surface of which the material becomes spread out by the action of centrifugal force. When solidification has taken place there is obtained a casting whose outer conformation is a reproduction of the internal shape of the mold, and whose inner surface is cylindrical and symmetrical about the axis of rotation. This process has been experimented with for a hundred years or more, has been the subject of numerous patents for nearly as long, and has long been in commercial use in this and in other countries.

Vertical casting also has been practiced for a long time, but in its application has not found nearly so broad a field as has the horizontal method. Here again the method consists essentially of introducing molten metal or other fluid material into a rotating, but in this case vertically mounted, mold. Instead of forming a cylindrical inner surface, as in horizontal work, the metal here takes a bowl-shaped form; the shape of this curve is that of a paraboloid of revolution, and the higher the speed of rotation, the more nearly parallel will the sides of the paraboloid become. If the speed is kept relatively low the resulting casting will be only moderately hollowed out, or dish-shaped, and with intermediate speeds intermediate results will be obtained.

If the axis of rotation be inclined, a casting with a more or less bowl-shaped interior will result, and here too, by properly adjusting the speed, the bore of the casting may be made to approximate either the near-cylindrical or the bowl or dish shape. Mathematically considered, the inclined axis opens to us the general case, a concentric centrifugal casting made in any position; the horizontal and vertical positions are special cases at the two limiting extremes of the general proposition.

Castings with Paraboloidal Bores

The production of castings with paraboloidal bores by use of inclined or vertical methods is covered in a number of patents extending over the past fifty years. However, there is nothing to indicate that control of these methods was developed very far, and it is probable that their application was so limited that until lately there was no great need for refinement of control. We shall here refer to a few of the more important of these patents, and analyze the principles involved.

British patent 3819 by Taylor and Wailes in 1878 states that the inner surface of the casting forms "in fact a ring-shaped section of the paraboloid of revolution which is the form taken by the free surface of a mass of heavy liquid in rapid rotation round a vertical [or inclined] axis;" British patent 21,213 by Huth in 1895 states that the metal "is thrown to the periphery and is raised in such a manner as to form a parabolic curve to correspond with the velocity of rotation....The parabole....depends upon the radius of the wheel and the velocity of rotation;" and patent 98,673 by Davies in 1870 mentions the "hollow" or "basin" that forms in the center. The Huth and Davies patents are both for vertical machines; there is nothing to indicate whether or not work had been done with an inclined axis, but Taylor and Wailes are very clear on this point. Huth knew that a paraboloid was formed when casting vertically, and Taylor and Wailes were clearly aware that when made in any position other than horizontal the casting would have a paraboloidal or basin-shaped bore. Davies proposed to cast cannon by his method, and Huth showed how, when casting shells, his plan was adaptable to making the bore of the casting somewhat conform by its paraboloidal shape to the pointed shape of the shell.

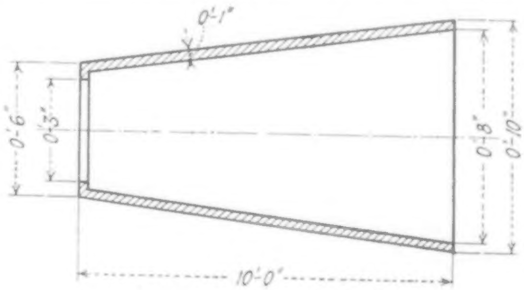

Fig. 1 Dimensions of Desired Casting

The inclined or the vertical method is indicated wherever the requirements of the shape of the bore can be approximated by a paraboloid, as for instance in the production of a casting whose finished bore is to be the frustum of a cone. The specific purpose for which this control was devised and used was the production of hollow tapering brass castings about 6 in. in diameter and upward of 20 ft. long for submarine-periscope tubes. However, as the solution is here worked out for the general case, it may be used to determine conditions for making concentric centrifugal castings of any size and in any position. Owing to the simplicity in principle of horizontal casting, it finds but little application there; inclined casting, however, is not so self-evident in principle, and really requires this exact means of control which is especially useful in connection with large work where cut-and-try methods are ruinous and where dependable data must be at hand before adequate specifications can be drawn for equipment, or intelligent plans made for its use.

It can be shown that the bore of a casting made with axis inclined is paraboloidal, and that the equation of the parabola has the form $x = ay^2$, with the axis of X coinciding with the axis of the casting and with the vertex at the origin. The coefficient a has the value $a = 0.61463\ (R^2/\sin\alpha)$, where R is the revolutions per second and α is the angle of inclination of the axis. Another value for the coefficient a is found to be $a = L/(y_2^2 - y_1^2)$, where y_2 and y_1 are any two radii (in feet) of the bore, and L the axial distance (in feet) between them.

Production of a Given Casting

Suppose now it is desired to produce a rough casting which will allow of machining to the shape and dimensions shown in cross-

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section in Fig. 1. Allowing finish on the various diameters and extra length for cropping, the rough casting to be obtained, with its dimensions, may be taken as shown in cross-section in Fig. 2, which also illustrates where the parabola will be located with respect to the casting.

Taking the radius of the large end of the rough casting as y_2 and the radius of the small end as y_1, the equation of the parabola which will generate the required bore is found to be $x = 121\ y^2$.

At this point it is well to determine the speed range within which the parabola $x = 121\ y^2$ may be produced. From the equivalent expressions for the coefficient a it is seen that for every assigned value of inclination α there will be a corresponding value for R, the speed of rotation. In the example before us the highest speed that may be used is found by assigning the values $a = 121$ and $\alpha = 90$ deg., which makes $R = 14$ revolutions per second or 840 r.p.m., for the mold vertically placed.

For a very elongated parabola, owing to the high value of the coefficient a the speed corresponding to vertical or steeply inclined positions may come out so high as to show at once that only moderate values of α should be selected if it is desired to avoid excessive speeds of rotation.

The lower limit of speed may be found, theoretically, at the

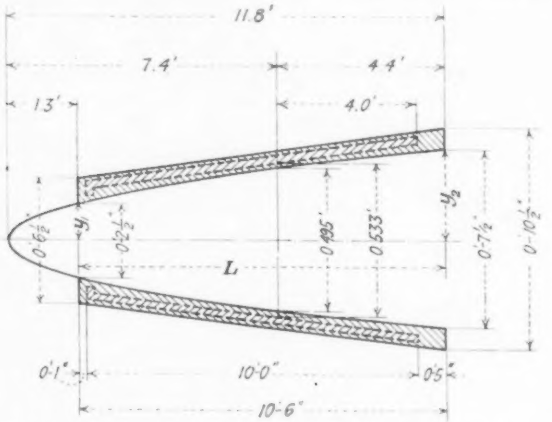

Fig. 2 Rough Centrifugal Casting for Machining to Dimensions Shown in Fig. 1

least inclination whose corresponding speed value is just sufficient to carry the metal around in the mold. This theoretical lower limit need not be solved for, however, as requirements of practice naturally demand a higher value, determined experimentally or in regular operation. If we assume that the lowest practical speed for a casting of this type has been set at 400 r.p.m. we may then use the values $a = 121$ and $R = 400/60 = 6.67$, getting thereby the value $\alpha = 13$ deg. inclination. For every value between 13 and 90 deg. there may be found in similar fashion a corresponding speed value lying between 400 and 840 r.p.m., and every correlated pair will produce identically the same shape of casting. (This suggests the somewhat odd conception of the possibility of a rotating mold waving irregularly about during the casting operation without detriment to the shape of the casting, provided only that the rotation be accelerated or retarded in harmony with the gyrations of the apparatus.) It may happen, in case the coefficient a has a low value, that the lowest speed permitted by requirements of practice can be attained or approached only by use of the highest speed allowed by the equation of the bore, i.e., by using the vertical position; a good example of this may be found in the Huth patent.

From the foregoing will be seen the utility of these calculations in the design of equipment. By ascertaining the equation of the parabola that will give to the bore the desired shape, and then by assigning the desired speed or range of speeds of rotation there may be obtained immediately the angle or the range of inclination of axis, which must be known before plans for the casting equipment can be laid out. Conversely, having given the range of speed and the range of inclination of any machine, it is then possible to ascertain whether any particular piece of work will fall within those limits.

Weight of Metal Required

Having found the relations between inclination and speed, it is convenient to find the weight of metal needed to form the casting. This is done by taking the difference between the volume of the mold (frustum of a cone) and the volume of the bore (frustum of a paraboloid) and applying to it the per-unit weight for the metal used. For the case in hand the volume is thus found to be, by well-known formulas, 2.42 cu. ft., which, if the metal weigh 500 lb. per cu. ft., indicates 1210 lb. as the weight needed to make the given casting. Shrinkage may be allowed for in the per-unit weight used. In this connection it is worth while noting that no matter what be the per-unit weight of the material, the control equations are not changed; conditions relating speed, inclination, and shape of bore are the same whether for lead or for aluminum.

As in other matters, many specific cases will be found to have features peculiar to themselves for which special provision must be made. For instance, after ascertaining the equation of the parabola that would fit in with the rough inside diameters assigned in Fig. 2, it would be desirable to find out whether the bore as cast would encroach at any point upon the thickness of extra metal needed for inside finish, owing to the bulging shape of the sides of the parabola. In some cases these factors can be taken care of without calculation, in others it may be necessary to determine the diameters of the rough bore at certain points, or to solve by familiar methods for the slope of the curve (for parabola of form $x = ay^2$ the slope is $1/2\ \sqrt{(ax)}$ or $1/2\ ay$), to compare this slope with the shape of the finished bore at and near the point under examination and then to modify the parabola accordingly if necessary. To illustrate, the slope of the wall of the finished casting (Fig. 1), is $\frac{1}{2}(10 - 6)/120$ or 0.0167, corresponding to 0 deg. 57 min., while the slope of the parabola at the large end of the casting, where y has been found to be 0.3125 is $1/(2 \times 121 \times 0.3125)$ or 0.0132, corresponding to 0 deg. 46 min., which being less indicates that there will be at least some encroachment of the kind mentioned. By investigating the amount and the location of this encroachment by a side calculation, it will be found that there remains a finish of $\frac{7}{16}$ in. on the inside diameter at the most critical point. If this finish is not enough, the lack is made up by taking a smaller inside diameter for either end or for both ends of the rough casting and recomputing the parabola.

Application of Calculations to Long Tubes

Another use to which these calculations could be put is to control the casting of long cylindrical tubes of small diameter, in which there might be some likelihood of the metal not reaching evenly to the far end of the mold before freezing. In cases like this it is evident that the cylindrical shape could be approximated by setting the mold at a slight inclination and driving it at first, during introduction of the metal, at a speed relatively low, thus giving the metal a chance to flow downward, then increasing the speed so as to obtain the near-cylindrical shape. This plan is closely equivalent to the mode of operation in a number of old patents, among them 648,601, Stridsberg, year 1900. By calculating the shape of the bore for the several speeds used this kind of control could be developed quite satisfactorily. Speed requirements for the vertical casting of near-cylindrical shapes may be calculated in a similar way. No illustrations are needed here because the computations are similar to those already described, differing only in their application.

Regulation of Speed or of Centrifugal Force

Reference was made to the fact that calculation of the theoretical lower limit of speed was made unnecessary by reason that requirements of practice demand a higher value. By this is suggested a question upon which there has been a little difference of opinion among various operators of centrifugal casting processes, and since it directly concerns the subject of control a brief analysis of it here should not be out of place. Let us say that in order not to rotate the mold so slowly as to run the risk of spoiling the casting, a certain speed of rotation has been settled upon and accepted as the most favorable one for castings of a certain diameter. It seems pretty well agreed that having been determined for one diameter, this favorable speed condition should be extended, if possible, for the sake of uniformity in practice, to cover other diameters. In the main, two different means have been adopted in the effort to

(Continued on page 730)

Avoidable Waste in Locomotive Operation as Affected by Design

By JAMES PARTINGTON,[1] NEW YORK, N. Y.

The best way to overcome waste in locomotive operation is to design the locomotive in the first place so that it will fulfill the efficiency requirements of

1 A drawbar horsepower for the minimum amount of fuel
2 A drawbar horsepower for the minimum amount of weight of locomotive and tender
3 A drawbar horsepower for the minimum cost of repairs.

Fuel economy is effected by firebrick arches, superheaters, feedwater heaters, generous steam spaces, automatic stokers, etc. Minimum weight is secured by careful design of the machinery parts, use of special materials, use of the independent booster for special grades. Minimum cost of repairs is dependent on the use of as few bolted parts as possible, accessibility of parts, removability, and interchangeability. Standard replacement parts can be secured from builders.

Much waste in locomotive operation can be avoided by making a careful study of present motive-power equipment, modernizing it where necessary, or replacing it by new equipment.

IT SEEMS advisable to consider this subject from the constructive standpoint of indicating what constitutes good design as demonstrated by locomotives in actual service, rather than to attempt to point out the defects in locomotives which do not show maximum efficiency. If any power plant or engine is not properly proportioned for the work it has to do, the most expert skill in operation can reduce only in part the waste resulting from having such equipment in service.

First, considering the design of steam locomotives from the standpoint of new equipment, when a railroad company is in the market for new locomotives its requirements may be met sometimes by duplicating locomotives in service on their road, but adding newly developed attachments which make for increased efficiency and economy. More frequently, however, it will be found that increased traffic, change from wooden to steel cars, improvement in track, roadbed and bridges, etc., will justify and make advisable the adoption of locomotives of a larger and more powerful type.

Then careful consideration must be given to service requirements —maximum loads to be hauled, capacity of cars, approximate proportion of loaded to empty cars per train, grades, curves, running time over divisions, maximum allowable load per axle, location of coal chutes and water tanks, clearances, conditions under which trains must be started, and any other special requirements of the service.

Having determined the drawbar pull necessary, it remains to design a locomotive that will have the following efficiency requirements:

1 A drawbar horsepower for the minimum amount of fuel
2 A drawbar horsepower for the minimum amount of weight of locomotive and tender
3 A drawbar horespower for the minimum cost of repairs.

Fuel Economy

As standard practice in modern locomotives, a sectional brick arch in the firebox and a fire-tube superheater should be applied as a means of saving fuel in any class of service. A sectional brick arch is low in first cost, easily applied and easily renewed. It usually accomplishes a fuel saving of from 10 to 12 per cent in coal-burning engines, and about 5 per cent in oil-burning engines.

The very general use of superheaters has gradually brought about improved conditions of cylinder lubrication which now make it possible and desirable for the greatest economy to use a high degree of superheat, 250 to 300 deg. now being considered the best practice. A saving of 25 to 30 per cent can be obtained.

The use of feedwater heaters will further conserve fuel, and these are now in general use in continental Europe and are gradually being applied to locomotives in the United States. The saving that can be realized is as much as 12 per cent. The initial cost is considerable, but the effect of the feedwater heater in operation, aside from fuel economy, will be to help reduce other boiler-maintenance charges.

The general proportions of the boiler should also receive careful consideration. For the best results with bituminous coal, the length of the boiler tubes should be approximately within the following limits:

Size of tube, in.	Distance over tube sheet
2	18 ft. 0 in. to 19 ft. 6 in.
$2^1/_4$	22 ft. 6 in. to 24 ft. 6 in.
$2^1/_2$	28 ft. 0 in. to 30 ft. 0 in.

For many designs of locomotives, a combustion chamber can be provided, and this will help further in the economical production of steam. A generous steam space should be provided, and the throttle designed and located to secure dry steam. The evaporative capacity of the boiler should be as nearly 100 per cent of the maximum steam requirements of the cylinders as the type of locomotive will permit. Based on 100-per cent boiler, the grate area should be sufficient to prevent the maximum coal consumption per sq. ft. of grate per hr. from exceeding, for bituminous coal, 120 lb., and for anthracite coal, 55 to 70 lb., depending on size.

When the total coal consumption exceeds 6000 lb. per hr., it is generally necessary to apply an automatic stoker. These have now been so adapted to locomotive requirements that a properly designed stoker will show economy over hand firing, aside from the necessity of its use on account of the coal consumption being greater than the physical capacity of one fireman if the boiler were hand-fired.

The arrangement of deflector plates and netting in the smokebox should be carefully adapted to the fuel and combustion conditions, to provide minimum fuel waste and minimum back pressure in the cylinder-exhaust passages with proper provision against fire hazards which might obtain by the throwing of sparks.

The boiler being designed to produce steam at a minimum cost, it is now necessary to design the engine to use this steam with maximum economy.

The cylinder proportions and diameter of the drivers should be such as will develop maximum horsepower at the ruling speeds for train movements. The greatest horsepower of locomotive cylinders will usually be developed within a piston speed ranging from 700 to 1000 ft. per min. Therefore, if other traffic conditions will permit, the operation of trains within these limits should show the greatest operating economy.

Minimum Weight of Motive-Power Equipment

The weight on the locomotive drivers gives an engine friction, independent of other factors, of 22 lb. per ton. The desirability of avoiding excess weight on the drivers from this standpoint alone is therefore readily apparent. When the type of engine will permit, this weight should not exceed what is necessary to give a satisfactory factor of adhesion; this is usually $4^1/_4$ times the maximum tractive power. All weight in excess of this and all other excess weight and excess tender weight should be eliminated, as far as this can be done without detriment to the design of engine and tender. This applies with particular force to the machinery parts of the engine, especially those parts which affect the counterbalance. All saving in weight in these parts usually produces a similar saving in counterbalance weights and a reduction in the dynamic augment, which is very desirable from the standpoint of track and roadbed maintenance.

The use of special materials to keep down weight is often amply justified if repair parts can be obtained promptly when required.

[1] Estimating Engineer, American Locomotive Company. Mem. Am. Soc.M.E.

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This, in the past, has often been the cause of delay, but it can be guarded against by carrying a few spare parts in stock ready for renewals. High-tensile alloy steel can frequently be used to advantage for driving axles, crank pins, main and side rods, piston rods, etc.

Occasional steep grades or hard starting conditions at stations may cut down the hauling capacity of locomotives over a division to a serious extent. In such cases, the utilization of the weight on trailer trucks for additional tractive power in starting and at slow speeds may increase the capacity of the locomotive from 10 to 25 per cent, depending on the number of driving wheels and working pressure. It has been demonstrated that a separate steam engine or booster geared to the trailing axle will give this additional traction, and that it can be cut in or cut out very satisfactorily as occasion may require.

This is an item in economical operation worthy of consideration where hauling capacity is restricted by such limitations, and the use of an independent booster may often permit the satisfactory operation of considerably lighter locomotives for service of this character.

Within the limits of this paper, only the major features of design can be outlined briefly, and only such devices as have been carefully tried out and are in successful operation are cited. The writer believes the savings mentioned are well within what may be obtained in practice.

Many other improvements promising further economy in the generation and use of power in the steam locomotive are contemplated and in the experimental stage, but these do not properly come under the scope of our subject as here treated.

Cost of Repairs

It has been pointed out that locomotives and tenders should be designed to produce the required drawbar horsepower with as little excess weight as possible. In this connection, however, due consideration must be given to the question of repairs.

The design of boilers from the standpoint of weight is practically fixed by existing boiler regulations, which provide that locomotive boilers must be operated with a factor of safety of not less than four. Practically all boilers at the present time are designed with a factor of safety of $4^1/_2$, which leaves a comfortable margin between this and the minimum allowable operating factor.

The maximum stresses in other parts of the locomotive must also be carefully considered, and the parts must be designed to keep these stresses within limits which will eliminate costly failures in service.

Aside from the consideration of stresses, much repair cost can be avoided by adopting designs which reduce the number of parts, as far as reasonably may be, especially where these parts must have bolted connections. Here, however, care must be taken to avoid construction which cannot readily be removed for repairs or renewals or repaired in place with reasonable facility.

Many roads today are giving a great deal of thought to locomotive design along these lines, having especially in mind the desirability of making the engine parts:

- Accessible for oiling and inspection
- Easily removable with proper shop facilities
- Of the minimum number of pieces
- Interchangeable with equipment now in service.

The repair-shop facilities must, of course, be kept abreast of the requirements; i.e., as new and larger locomotives are put in service, turntables, cranes, machine tools, etc. must be of sufficient capacity to handle the larger equipment economically.

The repairs of locomotives can often be facilitated and the necessary shop equipment kept down to the minimum by securing from the locomotive builder many parts which he is able to turn out more accurately and more economically than the average railroad shop would be equipped to do. Such parts include:

- Flanged sheets for boiler repairs
- Flexible and ordinary staybolts
- Finished bolts and nuts
- Drop forgings
- Packing rings for pistons and piston valves
- Special equipment which requires special tools for its production.

Without attempting to pursue further the design of new locomotives it may be remarked that a study of the special conditions of individual railroads is necessary to secure equipment best suited to the needs of each.

Old Motive-Power Equipment

Much waste in locomotive operation can be avoided by making a careful survey of present motive-power equipment which is not giving as economical or efficient service as could be obtained if the engines were modernized. This applies particularly to locomotives where the service conditions demand more power than the present equipment can economically produce. All the suggestions made in regard to the design of new equipment are applicable to a greater or less degree to old equipment, providing the old equipment is not meeting the demands of the service from a power standpoint, or is not furnishing this power economically.

In making a survey of this character care should be taken to determine accurately whether the old equipment will warrant the additional cost of changes and betterments necessary to convert it into up-to-date power. This can be decided by taking the number of years the engines will be retained in service and the increased net return or saving for this period as against the cost involved for changes, interest on the additional investment, increased maintenance, etc.

A comparison should also be made with the results that could be realized by the purchase of new equipment best adapted for the service, as against the cost of contemplated changes in the old equipment.

If these comparisons show a saving in favor of modernizing the old equipment or the purchase of new equipment, every month that the engines are kept in service without doing this will result in a loss that is not recoverable. A few concrete examples of what has been accomplished in service by locomotives designed to yield maximum efficiency may be of advantage. Notable designs, for which data is available, are as follows:

- Pacific type passenger locomotive No. 50,000 built by the American Locomotive Company
- Decapod type freight locomotive, Class I1s, built by the Pennsylvania Railroad Company
- Heavy Mallet special service locomotive built for the Virginian Railway by the American Locomotive Company.

The full paper gives performance records of these three engines.

CONTROL OF CENTRIFUGAL CASTING BY CALCULATION

(Continued from page 728)

bring about such uniformity, and these are, first, to so regulate the speed in r.p.m. as to hold the peripheral speed at a constant figure, or, second, to so regulate it as to hold the centrifugal force at a constant figure, for all diameters. A third plan is to so regulate the speed as to keep at a constant figure the tensile stress, regarding the casting as the rim of a flywheel, which it resembles in certain respects as soon as solidification has gone far enough to allow shrinkage to begin to draw the casting in, away from the sides of the mold. If the first plan is examined, it will be seen that the r.p.m. must vary inversely as the diameters; in the second plan, on account of the nature of centrifugal force, the r.p.m. will have to vary inversely as the square roots of the diameters; the third plan figures out like the first. The second set of conditions is therefore irreconcilable with either of the other two, which indicates that any effort to find conditions under which the metal of similar castings of different diameters would be subjected to identical physical forces is likely to be a prolonged one.

Conclusion

In closing it may be observed that possibly some foundrymen will look askance at what may seem so far from sand and patterns; they may rest assured, however, that what has been set down here is of an entirely practical nature in the field within which it applies, and that once understood in principle the calculations described do not offer the difficulty nor require the time that might be anticipated on first reading.

Making Work Fascinating as the First Step Toward Reduction of Waste

By WALTER N. POLAKOV,[1] NEW YORK, N. Y.

Confusion of classes of life has resulted in building up of industry around the mistaken idea that workman is an animal and his work a commodity.

Personnel administration, employment and compensation methods recognizing the human nature of workers have failed in so far as they have either concentrated their efforts on the functions outside of the work itself or attempted to stimulate the animal instincts alone.

Such experiments as have been already conducted in uniting brain work with manual work have proved beyond any doubt that such a course liberates dormant or suppressed creative capacities of men and not only improves quality and quantity of production but, above all, substantially ameliorates industrial relations. As to the parties to industry, the advantage to be derived from such an industrial organization that brings mind into labor and makes work fascinating, are at once beneficial to owner group and to the labor group.

Owners thereby develop a steady, contented, intelligent and highly productive personnel, thus eliminating a major part of past and present embarrassments, conflicts and losses. The labor group simultaneously frees itself from the oppressive feeling of drudgery of work, satisfies its human consciousness, secures opportunities for intellectual and technical advancement and improves its material status.

Management for the first time in history attains a position of dignity and stability, since its prime function becomes that of the liberation and direction of human, creative functions instead of partially utilizing only the physical power of men.

INCREASED production has been sought by devising labor-saving machinery and by stimulating individual productivity of workers. The first method, while in itself productive of results, rapidly and inevitably developed two by-effects which greatly reduced the advantages anticipated: (*a*) Automatic high-speed machinery, sold at a high price, increases overhead often in excess of reduction in payroll, materially increasing the capital charges on manufacturing establishments; (*b*) automatic, semi-automatic, high-speed and single-purpose machinery of modern industry makes the work of its attendants monotonous because it lacks the stimulating interest furnished by work requiring exercise of the mental faculties. The general consequence of both these tendencies has been toward increased cost of production instead of expected reduction of expenses. In times of industrial depression, idle expensive equipment greatly increases the cost of ownership. The workers, on the other hand, failing to get stimulation and satisfaction from work as mere parts of automatic machinery, demand shorter hours of this drudgery and higher compensation with which they can buy the interest, stimulation and pleasure which they fail to find in the work itself.

The task before the engineer of today is to overcome the ill effects of automatization and mechanization of industry. The world needs the highest possible production and the workers demand creative self-expression in industry.

This obviously cannot be accomplished by scrapping existing machinery or putting a ban on further inventions and improvements, for such digression will not only throw us further back in output, but is contrary to the nature of mankind. Therefore, the solution will be sought in the development of means of abolishing the industrial monotony and drudgery of work by introducing into it intelligent, self-expressive, creative motives. The problem thus resolves into one of *making work fascinating* as a means of releasing the desire to work.

The early attempts to make workers personally more efficient are generally connected with the Taylor system of management. The characteristic features of this system are (*a*) specialized division of function, and (*b*) detailed time studies of operation. A score of years of trial of this system has clearly demonstrated its inherent, organic shortcomings in many industrial establishments. (*a*) Functional foremanship, with brain work divorced from manual work has made the performance of work still more automatic and irresponsible. Creative, intelligent work has also been removed from the shops themselves and concentrated in a planning department or general office, which lacks direct personal touch with workers. (*b*) Time studies and instruction cards, by standardizing workers' manipulations, have caused the operations to become still more monotonous, repetitive without variations and devoid of stimulative self-expression.

Time studies, motion studies and other means of studying the work are in themselves commendable as steps toward substitution of "guess" and "opinions" by measured *facts*. Unfortunately, however, all these means lead to standardization and mechanization of manipulations. Once man is lowered to the level of an automaton, the creative element is driven out of his work and subsequent difficulties are impending. Again, *while* the studies are being made, a healthy, stimulating interest in the work is aroused, especially if workers' coöperation is invited; but once completed, tabulated, registered and prescribed, they become a monotonous routine. Vigorous protests and even some legislation against this dehumanizing application of scientific methods in an unscientific manner have been the inevitable results.

Recognition of these fatal mistakes has prompted industrial engineers to concentrate on the shortcomings of management itself. These efforts have (1) decentralized the detached intelligence of the planning department by establishing manufacturing offices in the shops, (2) reunited the instructing and inspecting functions of foremanships, (3) substituted for time-study clerks the direct interchange of worker's skill and intelligence, (4) stimulated interest in the work by training and providing instruments for intelligent control of processes, (5) liberated the suppressed creative instincts of workers by providing them with means for observing their own progress, and, finally, (6) devised a charting method permitting the accurate measurement of managerial efficiency separately from the efficiency of workers.

Until recently the acceptance of one or another managerial policy was a matter of personal opinions or sympathies. The error of applying to the workingmen the rules and measures which take into account *only* their animal functions is that of confusing the part with the whole, inasmuch as the physical labor of men is but a part of their nature. This blunder, therefore, is even more fatal in industrial relations than a similar confusion of dimensions would be in mechanical construction.

On the other hand, the strength and correctness of our principle is in its recognition of the time-binding nature of men and consistent provisions for exercise on the part of workers of their *human*, creative functions together with liberation of purely mechanical work.

For some time past weariness of spirit and dissatisfaction with brutalizing monotony of work not only has made the workers in this country as well as abroad restless and irritable, but also has moved them to demand short hours and high pay for drudgery, while the quantity and quality of personal output has sometimes decreased in spite of concessions made.

This failure to recognize true human nature and its fundamental natural power constantly and forcibly seeking self-expression is the basic cause of the alarming extent of industrial waste. The report recently made by the committee of The Federated American Engineering Societies telling of waste in life, health, welfare and wealth caused by business and industry emphasized that: "From this knowledge will grow the certain vision that *mental and moral forces must be added* to the physical resources now employed, if industry is to serve all." It is significant that our losses are primarily due to the application of animal standards to human creative activities in industry.

[1] Consulting engineer, Walter N. Polokov & Co., Inc. Mem.Am.Soc. M.E.

For presentation at the Annual Meeting, New York, December 5 to 9, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form. All papers are subject to revision.

For some time past studies of industrial fatigue have attracted widespread attention both in this country and abroad. It has been proved by various investigators that a great deal of waste in production is due to unnecessary fatigue, as distinguished from allied factors. Moreover, while mere physical fatigue gives to the man unmistakeable warning, thus preventing physical breakdown, and recuperation is rapid and complete, the nervous and mental fatigue accumulates unnoticed.

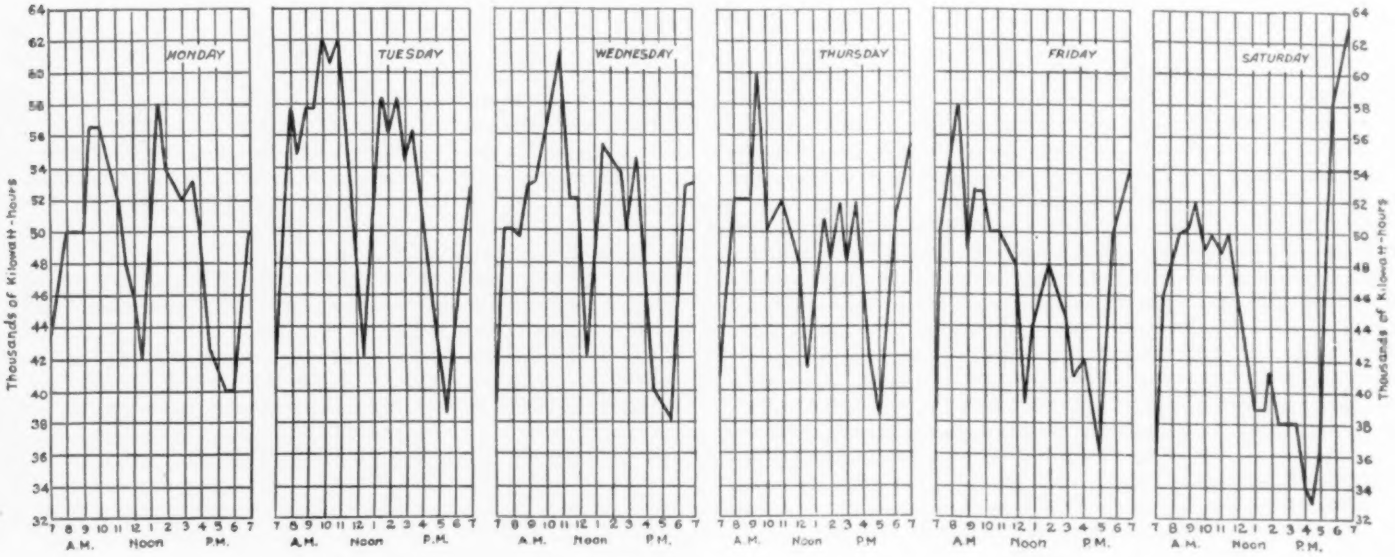

Fig. 1 Relation Between the Accumulation of Fatigue and Drop of Industrial Efficiency

Data collected by the author from records of public utilities supplying power to a variety of industrial establishments, averaging 52 Mondays, 52 Tuesdays, etc., and making a composite average load curve.

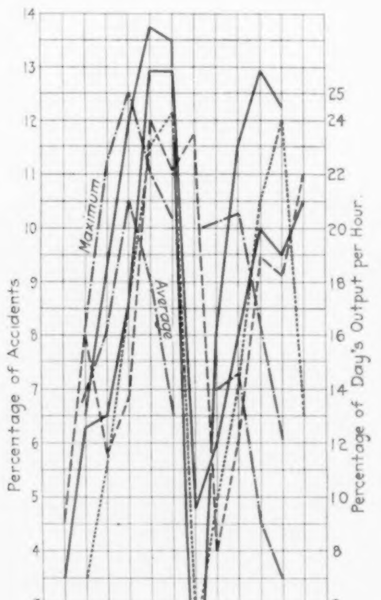

Fig. 2 Effect of Fatigue on Time and Frequency of Industrial Accidents (Due to Carelessness) and Power Used During Preceding Periods

Accidents follow production peaks in four different industries. Data collected at London docks and by several insurance companies in the United States; compiled by Chas. S. Myers, director of the Cambridge Psychological Laboratory.

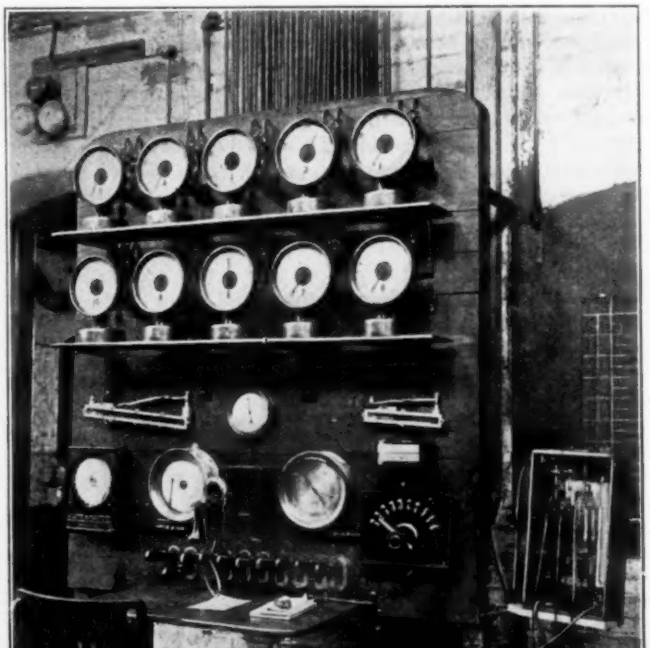

Fig. 3 Instrument Boards in Boiler Rooms Used for Intelligent Control of Processes, Largely Substituting Mental Work for Physical Exertion of Firemen and Providing Interest

that necessary for performance of work under the most favorable conditions. An even more important finding, however, is that physical fatigue itself is largely traceable to mental and nervous fatigue produced by the monotony of repetitive operations and

In this connection the elimination of monotony and the provision of mental and emotional stimuli, making work at least in a measure fascinating, is the fundamental requirement for reduction of such industrial wastes as irregular attendance, large labor turnover,

irritability of workers, inattentiveness, susceptibility to accidents, poor workmanship, high percentage of spoilage, low individual output, etc. Fig. 1 visualizes the well-established relations between the accumulation of fatigue and depreciation of industrial efficiency. Fig. 2 illustrates the effect of fatigue on the rate of industrial accidents, as well as relation to hourly outputs.

Even the most advanced employment methods alone are impotent to solve this problem, for they deal with men and working conditions *as they are*. If conditions be poor, only poor men can be selected

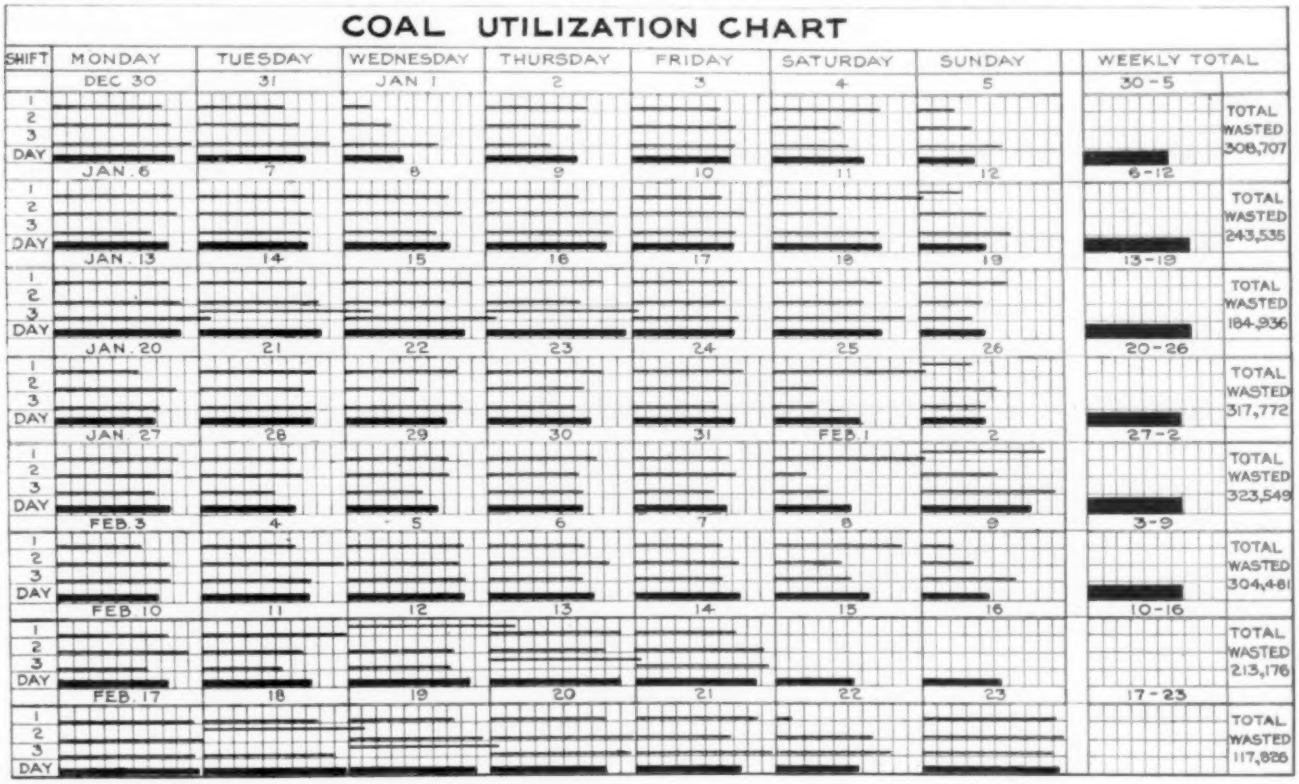

Fig. 4

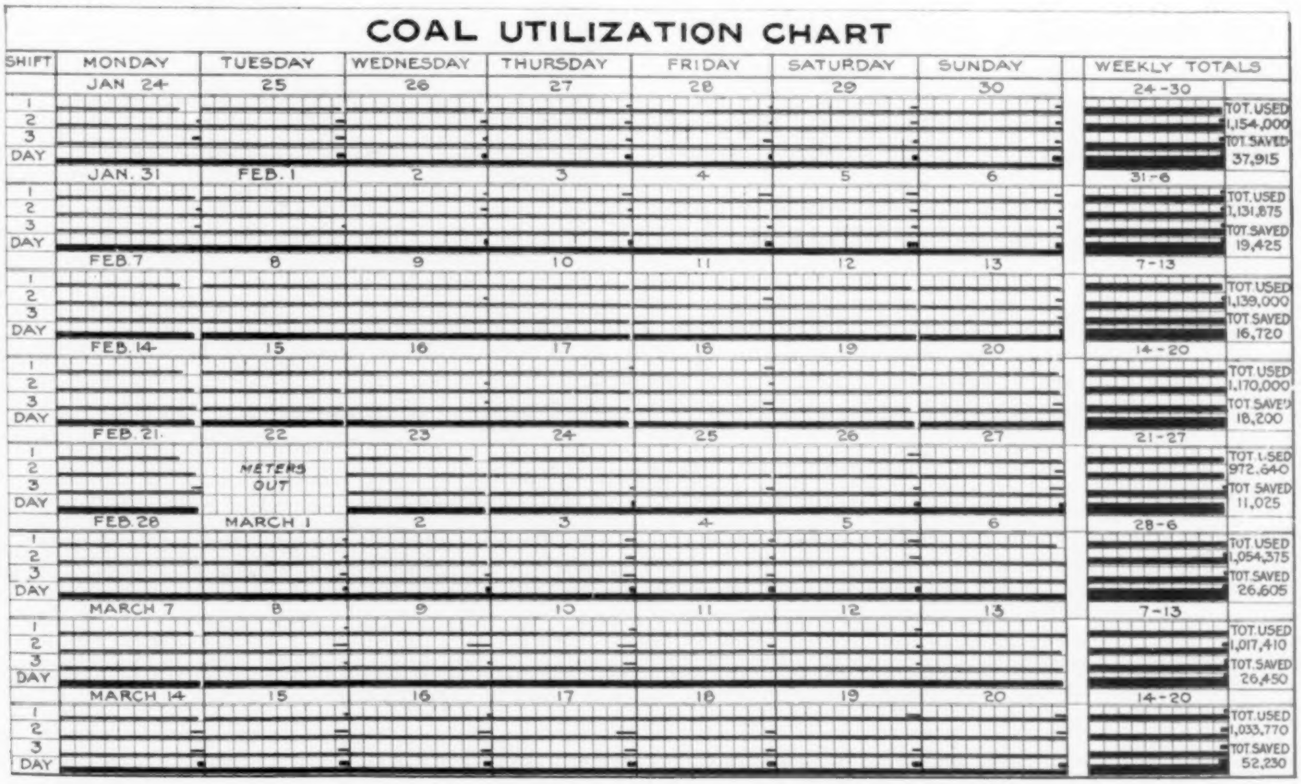

Fig. 5

Figs. 4 and 5 Coal-Utilization Charts

Based on efficiency obtained by each gang for each day. If efficiency is below 72 per cent the bars on the chart are proportionately short; if efficiency is higher than 72 per cent the bars are doubled up. Note the progress in elimination of waste from January 1919 to January 1921 on chart in Fig. 6.

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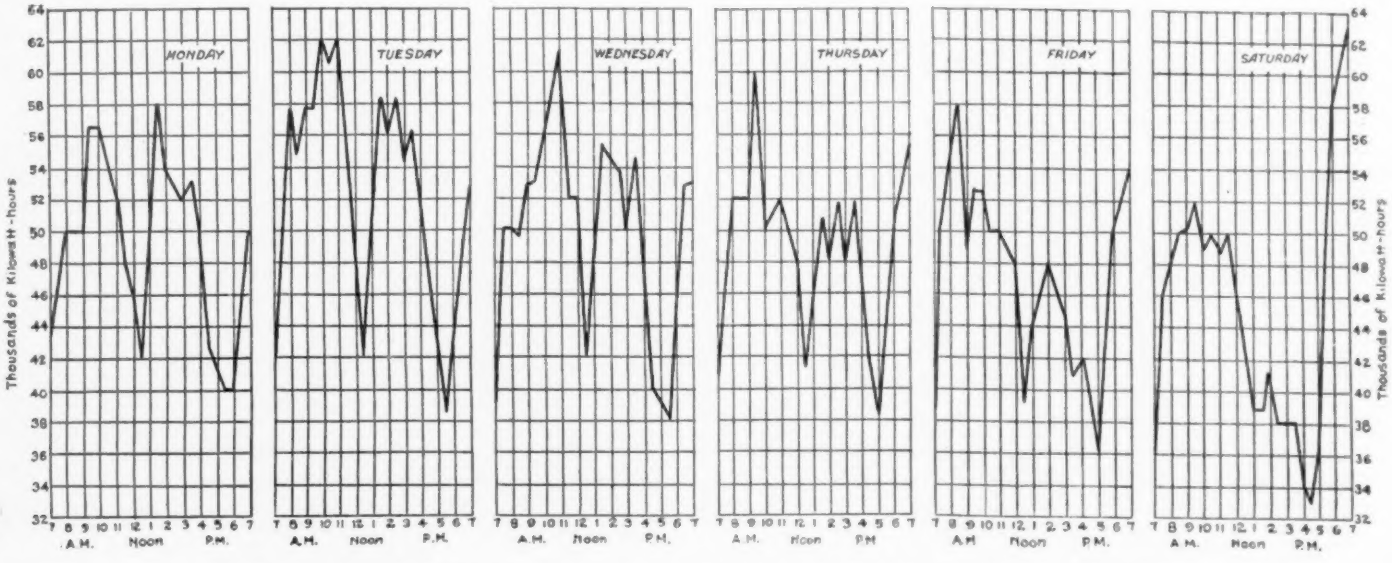

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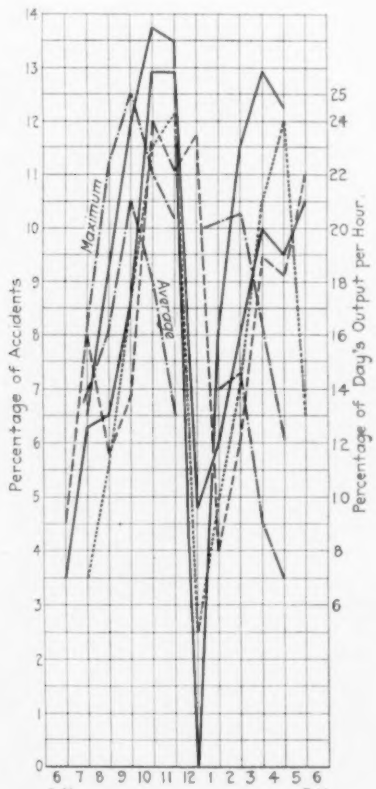

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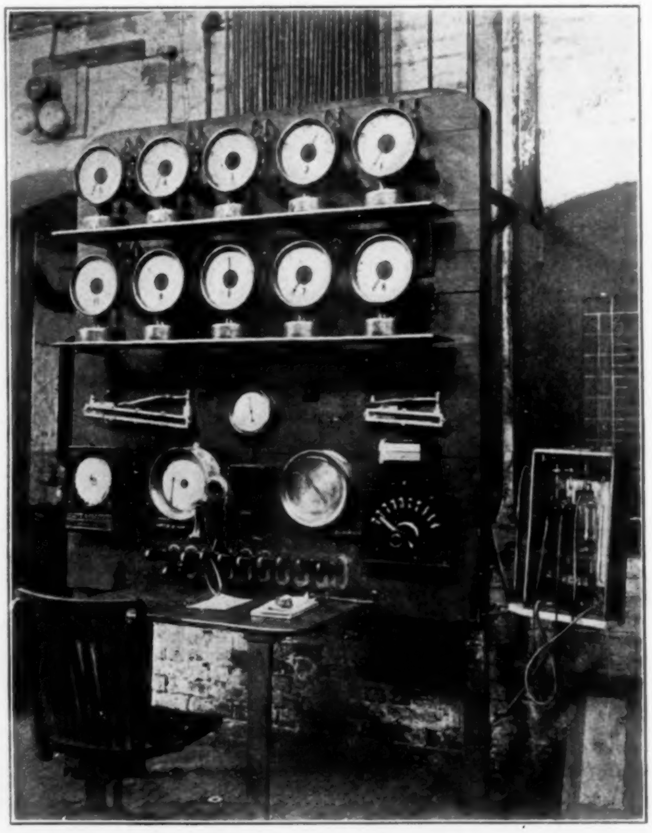

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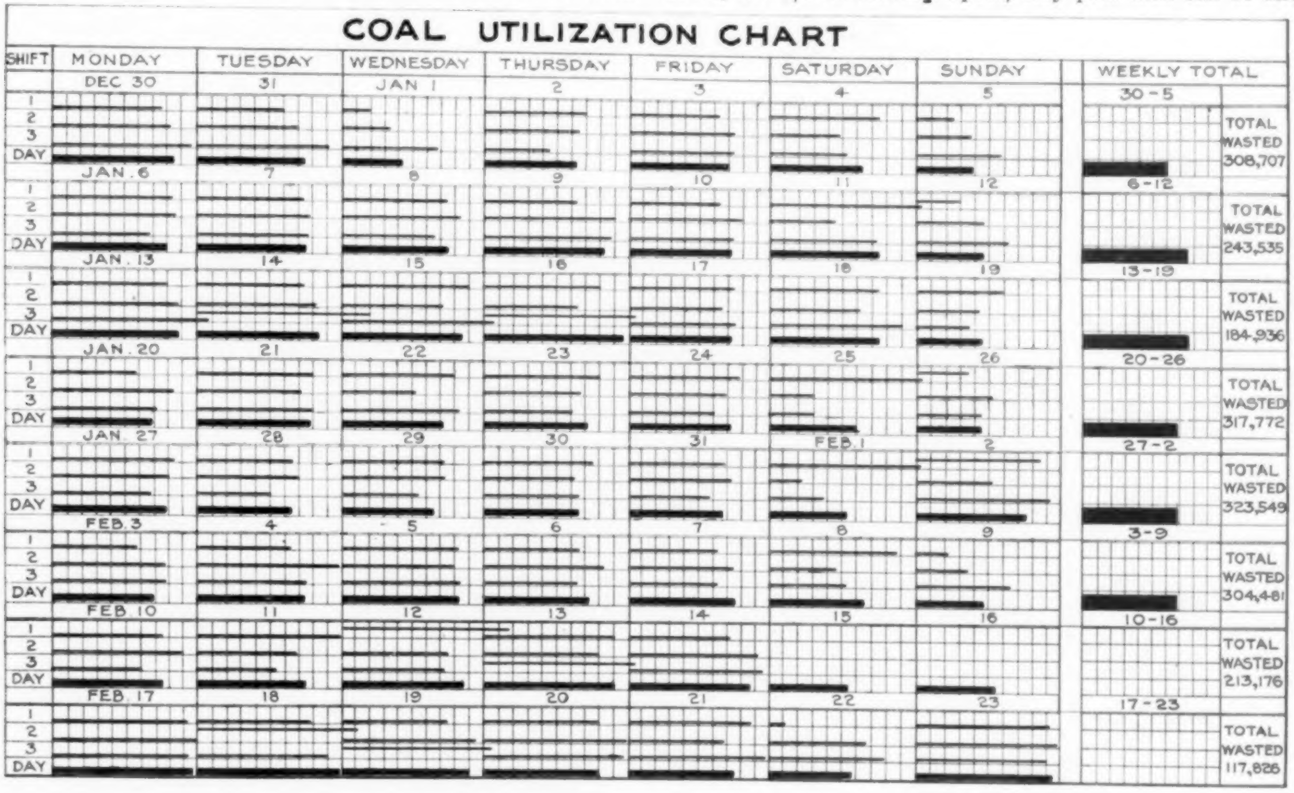
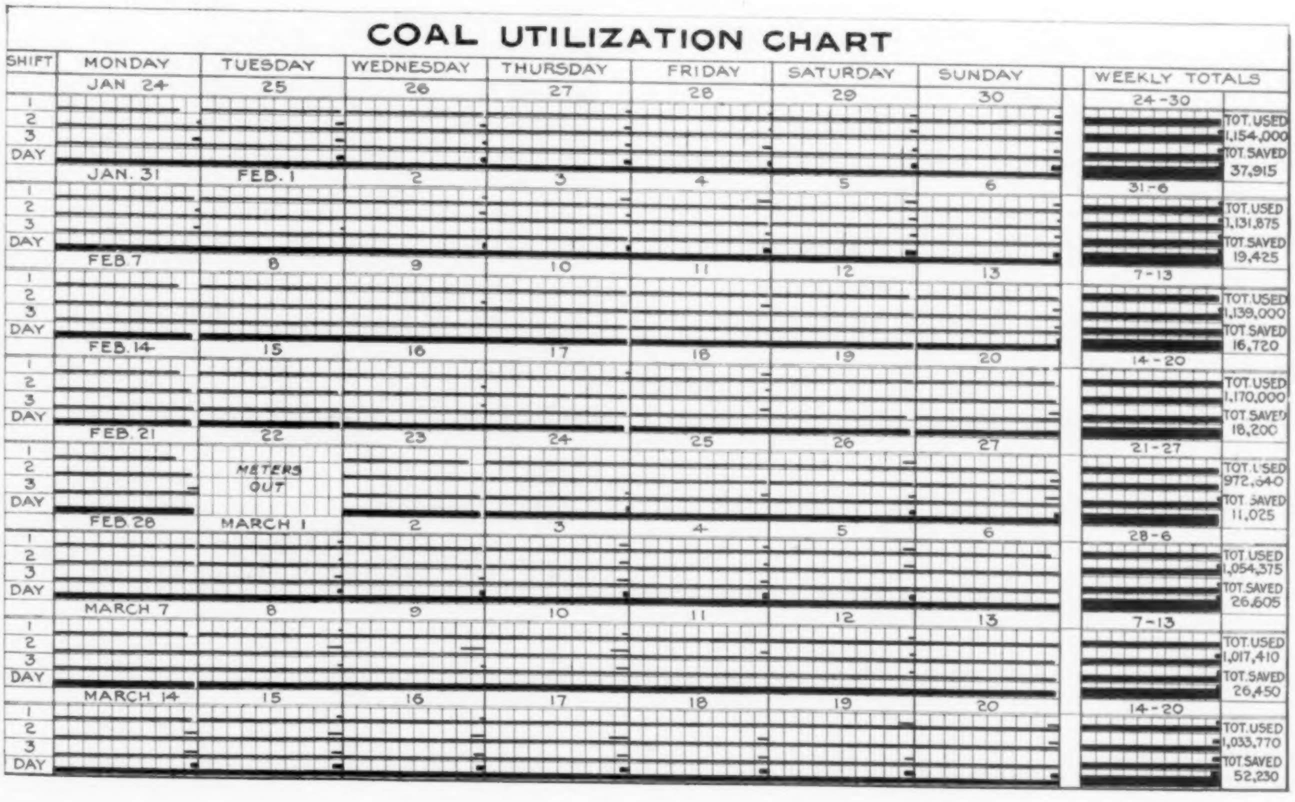


Fig. 4



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shortcomings have dealt however with only one side of the situation: not being engineering executives thoroughly versed with the processes and performance of work, it has remained outside of their jurisdiction to readjust jobs themselves so that workers can derive joy and satisfaction from performing the work.

It would be a mistake, however, to think that repetitive, monotonous operations lack fascination to every one. In fact, there are certain individuals who can best express themselves by performing a well-standardized operation. They find a delight in mere mechanical functions least interfering with an independently occupied mind wandering away from the job. This *imitative* type of men should never be confused with the *creative* type, and the selection of men and women should be practiced along these lines. As to the means of making work fascinating to either type, these are as different as the types themselves.

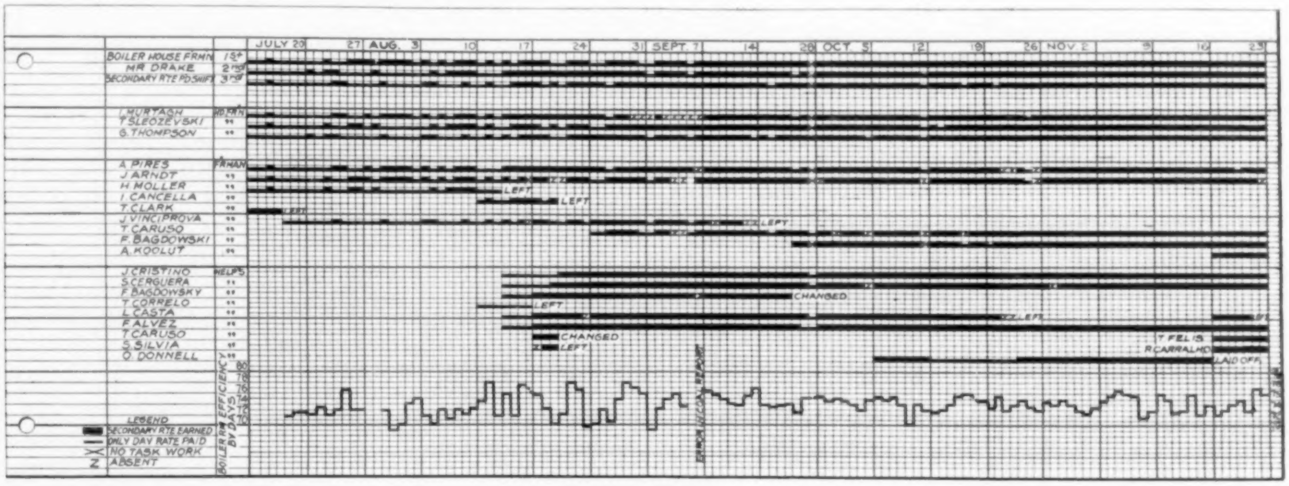

FIG. 6 COAL-UTILIZATION CHART

Showing progress of rapid learning from the beginning of the introduction of the new method.

Instinctively feeling that at the bottom of many labor troubles the monotony of animal-like work is to be found, a large number of manufacturing concerns have adopted a policy of diverting the attention of workers from the shortcomings of working conditions to the refreshing activities of "welfare" work. Some welfare organizations render their assistance in many industrial centers by establishing their Industrial Departments under the direction of men proficient in games. While a measure of success has been recorded in several instances, this movement is obviously directed along the wrong course. It attempts to *divert the attention from work to recreation.*

Incentives to higher production, so far as workers are concerned, have been offered, both financial and non-financial. To the first group belong a variety of such forms as profit sharing, differential piece rates, incentive payments, etc.; in the second group the non-financial incentives of Wolf stand alone. As a means for securing the interest of workers in the work itself, these incentive payments are obviously unfit, for they merely create interest in securing a larger pay. The work itself, in so far as it is spurred and speeded up by anticipation of a monetary premium, becomes still less attractive. If workers were left to themselves to devise more efficient productive methods to attain offered reward, these financial incentives could prove their human worth as mental stimuli for attaining perfection, were it not for the fact that neither workers nor their immediate leaders have sufficient technical training and research facilities to develop more efficient practice without the aid of specialists.

Non-financial incentives, on the other hand, have demonstrated the value of an environment which stimulates thinking. By having opportunity to constantly increase their knowledge of the underlying natural laws of the process, the workers are able to realize the joy which comes from a conscious mastery of their part in any process.[1] The creative activity is the final aim of human beings, yet to preserve life we must not only provide the material requisites of food, clothing and shelter, but meet also the higher demands of human life commensurately with the degree of culture and service rendered. Greater service rendered is both conditioned and followed by greater material reward. It is *conditioned*, inasmuch as a man who is kept by material limitations on a low level of hygiene, comfort, education and refinement cannot produce higher values in his work. It is *followed*, in so far as the higher development of man's creative power is capable of producing greater values. The nature of man involves the material side just as a higher dimension contains a lower. Consequently any wage system, in order to comply with human nature, should not confuse incentives for acquisitive passion with adequate provisions enabling wage earners to reach a higher plane of cultural and productive development. This aim can be attained by a two-rate wage[1] as developed and practiced by the author; it substantially consists of a fixed

(*Continued on page 765*)

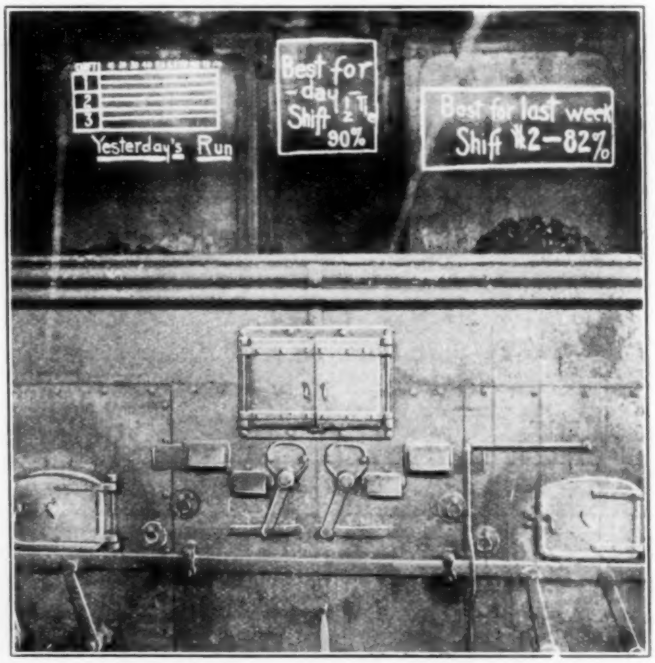

FIG. 7 MAN-RECORD CHART DRAWN ON FRONT OF BOILERS AND SCORE RECORDED BY MEN WHEN WORK HAS LOST ITS MONOTONY

The full length of space means expected economy (72 per cent boiler and stoker efficiency); short lines indicate falling short of full efficiency. Accordingly 90 per cent means about 65 per cent efficiency of boilers.

[1] Non-financial Incentives, R. B. Wolf, Trans.Am.Soc.M.E., vol. 40 (1918).

[1] *National Engineer*, Two-Rate Wage, Walter N. Polakov, presented before N. A. S. E. Convention in Huntington, W. Va.; also Mastering Power Production by W. N. Polakov, *Engineering Management*, 1921.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Economies Obtainable by Reducing Resistances in Steam Piping

By O. Denecke

Discussion of the general principles on which the design of steam piping in power plants should be based, with comparison of formulas suggested for various elements affecting steam consumption as a function of resistances encountered to the flow of steam. The following notation is used:

Notation in Original	Notation in This Abstract
Q	Q = weight of steam discharged from a pipe or passage, kg. per hr.
Q'	q = weight of condensation in the steam piping, kg. per hr.
l	L = length of steel piping, meters
d_{cm}	d = diameter of piping, cm.
p_1	p = steam pressure at exit, kg. per sq. m.
p_2	P = steam pressure at entrance into piping, kg. per sq. m.
Δ	l = total pressure loss in piping, kg. per sq. m.
Δ_R	r = pressure loss in piping due to friction, kg. per sq. m.
R	$R = r \div L$ pressure loss through friction in piping per meter of length of pipe
β	b = coefficient of friction in the piping
ζ	k = coefficient of resistance for individual resistances
Z	$Z = \Sigma lk$ = pressure loss in all the single resistances, kg. per sq. m.
γ_w	w = average specific weight of steam at $P_1 = (p + P) \div 2$, which is the average steam pressure in the piping, kg. per cu. cm.
v	v = average steam velocity, m. per sec.

I *Pressure Loss Due to Friction Only.* For conditions considered here the formulas

$$r = \frac{1.251\, bL}{wd^5}\left(Q + \frac{q}{2}\right)^2 \qquad [2]$$

and—since

$$\left(Q + \frac{q}{2}\right)^2 = Q^2\left(1 + {}^1/_2\,\frac{q}{Q}\right)^2 = Q^2\left(1 + \frac{q}{Q}\right)$$

$$r = \frac{1.251\, bL}{wd^5}\,Q^2\left(1 + \frac{q}{Q}\right) \text{ in kg. per sq. m.} \qquad [3]$$

taken from the German engineering handbook Hütte (22nd edition, vol. 1, p. 449), are sufficient.

The same handbook gives the values for the coefficient of friction, b, as a function of the weight of the steam, Q, as indicated in Table 1.

TABLE 1

Q	b	Q	b	Q	b	Q	b
10	2.03	100	1.45	1000	1.03	10,000	0.73
15	1.92	150	1.36	1500	0.97	15,000	0.69
25	1.73	250	1.26	2500	0.90	25,000	0.64
40	1.66	400	1.18	4000	0.84	40,000	0.595
65	1.54	650	1.10	6500	0.78	65,000	0.555
100	1.45	1000	1.03	10000	0.73	100,000	0.520

On the other hand, however, Fischer and Gutermuth have adopted a constant value $b = 1.5$ and obtained the formula

$$r = \frac{1.878\, L}{wd^5}\,Q^2\left(1 + \frac{q}{Q}\right) \qquad [3b]$$

extensively used for low-pressure steam-heating calculations.

Eberle recommends for high-pressure piping a constant value $b = 1.05$, which gives the formula

$$r = \frac{1.31\, L}{wd^5}\,Q^2\left(1 + \frac{q}{Q}\right) \qquad [3c]$$

The present author derives from Equation [3] an expression for pressure drop per running meter of pipe:

$$R = \frac{r}{L} = \frac{1.251\, L}{wd^5}\,Q^2\left(1 + \frac{q}{Q}\right) \qquad [4]$$

which may be also expressed in the following form more convenient for slide-rule calculations:

$$R = \frac{1.251\, b}{wd^5}\left(\frac{Q}{d^2}\right)^2\left(1 + \frac{q}{Q}\right) \qquad [4a]$$

and also:

$$d^5 = \frac{1.251\, b\, Q^2}{wR}\left(1 + \frac{q}{Q}\right) \qquad [5]$$

II *Pressure Loss Due to Individual Resistances.* (Changes of direction, cross-section of piping, bends.) Each individual resistance occurring at any point x in the piping creates a loss of pressure expressed by

$$lk_x = k\,\frac{v^2_x}{2g}\,w_x \qquad [5a]$$

which, with Q_x substituted for v_x, becomes

$$lk_x = \frac{0.64\; Q^2_x}{w_x d^4} \qquad [6]$$

where k_x is the coefficient of resistance, the values of which are given in the German Hütte (vol. 3, pp. 415 and 419), as ζ_v.

For the ranges of pressure which have to be considered in connection with ordinary power-plant design, and for all the individual resistances (k_1, k_2, k_3, etc.), one may with sufficient precision substitute for w_x its average w and hence write $Q_x = Q + \frac{q}{2}$, so that the total pressure drop across all the individual resistances together (Σk) is

$$Z = \Sigma lk = \frac{0.64}{wd^4}\left(Q + \frac{q}{2}\right)^2 \text{ or}$$

$$Z = \frac{0.64}{wd^4}\left(1 + \frac{q}{Q}\right)\Sigma k \qquad [7]$$

or

$$Z = \frac{0.64}{w}\left(\frac{Q}{d^2}\right)^2\left(1 + \frac{q}{Q}\right)\Sigma k \qquad [7a]$$

If a substitution be made here from Equation [4] we obtain

$$\frac{Q^2\left(1 + \dfrac{q}{Q}\right)}{wd^4} = \frac{dR}{1.251\, b}$$

and hence

$$Z = \frac{0.51}{b}\, d\Sigma kR \qquad [8]$$

This latter, with $b = 1.5$, in accordance with Fischer, gives the following expression suitable for low-pressure steam piping:

$$Z = \frac{d}{3}\,\Sigma kR \qquad [8a]$$

and with $b = 1.05$, according to Eberle,

$$Z = \frac{d}{2.06}\,\Sigma kR$$

Since, however, the values of k and b are somewhat uncertain for

ordinary calculations of high-pressure piping, the following equation may be used:

$$Z = \frac{d}{2}\,\Sigma kR$$

III *The Total Drop in Pressure* through friction and individual resistances in the entire length of pipe L is

$$l = P - p = r + Z$$

which with values for r and Z substituted from Equations [4] and [8] becomes

$$l = RL + R\,\frac{0.51}{b}\,d\Sigma k$$

$$l = R\left(L + \frac{0.51}{b}\,d\Sigma k\right) \quad \text{[9]}$$

$$l = R\,(L + Lk) \quad \text{[10]}$$

$$Lk = \frac{0.51}{b}\,d\Sigma k \quad \text{[11]}$$

In these expressions the individual resistances are replaced by lengths of piping which by friction produce the same drops of pressure as the respective resistances. Hence, for each $k = 1$ it will be necessary to increase the piping by a length equal to: (*a*) for low-pressure piping (according Equation [8*a*]), $d/3$ meters, and (*b*) for high-pressure piping (according to Equation [8*b*] for ordinary calculations), $d/2$ meters, or more correctly $0.51\,\frac{d}{b}$ meters, where b has the value given Fritzsche; the piping so lengthened should then be computed with respect to its frictional resistance. Thus, for example, if the pipe diameter is 49 mm. then for each $k = 1$ it should be increased in length for purposes of calculation in the case of low-pressure steam by $4.9/3 = 1.63$ meters, and for high-pressure piping by $7.35/3 = 2.45$ meters.

This method of calculation has the advantage of simplicity and ease of remembrance.

IV *Methods of Application* of the above equations for the solution of the problem: How to reduce, by decreasing the individual resistances, the pipe diameter, and hence the cost of pipe installation. There are given Q, L and the permissible pressure drop $l = P - p$, and it is desired to find the proper pipe diameter for each Σk.

(*a*) $\Sigma k = 0$ gives the smallest possible diameter d_o, since then the entire pressure drop l is due exclusively to friction. Since $Lk = 0$, we have according to Equation [10], $l = R(L + Lk)$

$$R_{\Sigma k=0} = R_o = \frac{l}{L} \quad \text{[11b]}$$

and according to Equation [5]

$$d^5 = \frac{1.251\,bQ^2}{wR}\left(1 + \frac{q_o}{Q}\right) \quad \text{[12]}$$

where q_o gives the amount of condensate per hour for the smallest diameter d_o. As q_o in well-insulated piping amounts to only a few per cent, the member $1 + \frac{q_o}{Q}$ has scarcely any influence on d and may be either neglected entirely or merely estimated.

(*b*) For any other magnitude of Σk a diameter $d > d_o$ has to be found, as in that case only part of the total drop of pressure l is due to friction. From Equations [4] and [10], it follows that

$$\frac{l}{L + Lk} = R\,\frac{1.251}{wd^5}\,Q^2\left(1 + \frac{q}{Q}\right) \quad \text{[13]}$$

while from Equations [4] and [11*b*] we find

$$\frac{l}{L} = R_o = \frac{1.251\,b}{wd_o^5}\,Q^2\left(1 + \frac{q_o}{Q}\right) \quad \text{[14]}$$

By dividing [13] by [14], we get

$$\frac{d^5}{d_o^5} = \frac{L + Lk}{L}\,\left(1 + \frac{q}{Q}\right)/\left(1 + \frac{q_o}{Q}\right) \quad \text{[14a]}$$

But since it may be assumed with no great inaccuracy that $1 + \frac{q}{Q} = 1 + \frac{q_o}{Q}$ and since further according to Equation [11], $Lk = \frac{0.51\,d}{b}\,\Sigma k$, the above equation becomes:

$$\left(\frac{d}{d_o}\right)^5 = 1 + \frac{Lk}{L} = 1 + \frac{0.51\,d}{bL}\,\Sigma k \quad \text{[15]}$$

Therefore, if the minimum pipe diameter d_o has been computed according to Equation [12] for $\Sigma k = 0$, the diameter d for any other value of Σk may be found from the equation

$$\frac{d}{d_o} = \left(1 + \frac{0.51}{bL}\,\Sigma k\right)^{\frac{1}{5}} \quad \text{[15a]}$$

or, more conveniently, for any pipe diameter $d > d_o$, the following holds good:

$$\Sigma k = \left[\left(\frac{d}{d_o}\right)^5 - 1\right]\frac{bL}{0.51\,d} \quad \text{[16]}$$

(*c*) Numerical example. Given:

Q = 3400 kg. superheated steam flowing per hour

L = 50 m., length of piping

p = 9 atmos. = 90,000 kg. per sq. m., final steam pressure at end of piping

P = 9.6 atmos. = 96,000 kg. per sq. m., initial steam pressure

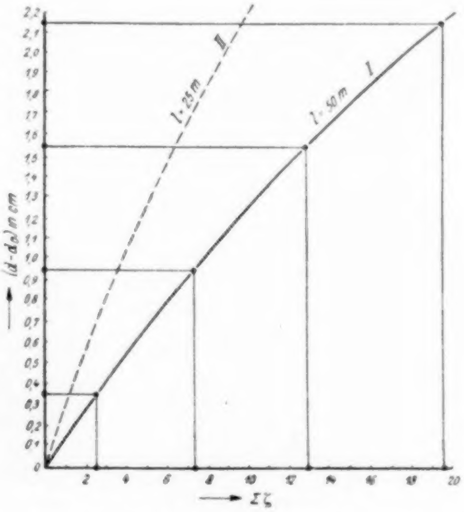

FIG. 1 CURVE SHOWING THE VALUE OF PIPE DIAMETER d AS A FUNCTION OF THE SUM OF INDIVIDUAL RESISTANCES Σk

(Note: 2,3; 2,1; etc. on the drawing mean decimal fractions 2.2, 2.1, etc.)

p_m = 9.3 atmos., = 93,000 kg. per sq. m., average steam pressure for an average steam temperature of 300 deg. cent.

w = 3.51 kg. per cu. m.

l = $P - p$ = 6000 kg. per sq. m., total pressure drop through the piping

$R_o = \frac{l}{L} = \frac{6000}{50} = 120$ kg. per sq. m., pressure drop per meter length of pipe.

According to Table 1 (Fritzsche) for $Q = 3400$ kg. per hr., $b = 0.864$ and according to Equation [12] for $\Sigma k = 0$, the minimum diameter is

$$d_m{}^5 = \frac{1.251\,bQ^2}{wR_o} = \frac{1.251 \times 0.864}{3.51 \times 120}\,(3400)^2 \quad d_o = 7.90 \text{ cm.} \quad \text{[12]}$$

The nearest commercial pipe size is $d = 8.25$ cm., and hence $\frac{d}{d_o} = \frac{8.25}{7.90} = 1.044$, which gives

$$\Sigma k = \left[\left(\frac{8.25}{7.90}\right)^5 - 1\right]\frac{0.864 \times 50}{0.51 \times 8.25} = 2.49 \quad \text{[16]}$$

The next larger commercial pipe diameters according to Equation [16] give

$$d = 8.85, \text{ hence } \frac{d}{d_o} = \frac{8.85}{7.90} \text{ and } \Sigma k = 7.3$$

$$d = 9.45, \text{ hence } \frac{d}{d_o} = \frac{9.45}{7.90} \text{ and } \Sigma k = 12.95$$

$$d = 10.05, \text{ hence } \frac{d}{d_o} = \frac{10.05}{7.9} \text{ and } \Sigma k = 19.60$$

These diameters d, or rather the differences $d - d_o$, plotted as ordinates (scale 10 to 1) with the values of Σk as abscissæ (scale 1 = 1 cm.), give curve 1, (Schmidt), Fig. 1. This shows how with the decrease of the individual resistances Σk the pipe diameter should be reduced and also permits figuring out the percentage of saving in cost of piping.

It should be noted though that the magnitude of the relative saving is affected not only by k but also materially by the length of the piping L, so that actually the guiding magnitude is the ratio $\frac{\Sigma k}{L}$, that is, the share of the total of the individual resistances for a unit length of pipe, or, say, 1 m. The smaller the value of L with the same $R_o = \frac{l}{L}$, the smaller according to Equation [16] will be the respective value of Σk for any given pipe diameter; therefore the curve will be steeper and the saving in pipe diameter with every reduction of Σk will be greater.

Thus, if in the above example, L have a value of 25 m. instead of 50 m., the values of Σk as computed from Equation [16] would have been only half as large, and instead of curve I in Fig. 1 we should have obtained curve II, which is much steeper. The shorter, therefore, the length of the piping, for example, between boiler and steam engine, the more the individual resistances, (such, for example, as the indispensable valves) increase the cost of piping by affecting its diameter.

V *General Solution.* The solution may be expressed in still more general terms, so that a single curve will suffice for all possible values of Q, L and l, for both saturated and superheated steam. In such a curve all that will be necessary will be to change the scale of abscissæ in order to read off the necessary pipe diameter under all possible kinds of operating conditions, the curve giving at once the diameter of pipe which becomes necessary through the decrease or increase in individual resistances.

If we multiply Equation [16] on its right-hand side by $\frac{d_o}{d_o}$ we obtain

$$\Sigma k = \left[\left(\frac{d}{d_o}\right)^5 - 1\right]\frac{bLd_o}{0.51\,d\,d_o} \qquad [16c]$$

which gives

$$\frac{0.51\,d_o}{bL}\Sigma k = \left[\left(\frac{d}{d_o}\right)^5 - 1\right]\frac{d_o}{d} \qquad [16d]$$

In this case the right-hand side is a function only of $\frac{d}{d_o}$ and is therefore independent of Q, L and l. If further, we equate on the left-hand side

$$\frac{0.51\,d_o}{bL}\Sigma k = x \qquad [17]$$

we obtain

$$x = \left(\frac{d}{d_o}\right)^4 - \frac{d_o}{d} \qquad [18]$$

which is an equation giving a curve suitable for all kinds of conditions and one that can be easily plotted with properly selected values of $\frac{d}{d_o}$.

Thus,

$\frac{d}{d_o}$	x
1	$= 0$
1.05	$= 0.263$
11.1	$= 0.555$
1.2	$= 1.241$
1.3	$= 2.087$
1.4	$= 3.127$

Fig. 2 gives a curve plotted with these values of $\frac{d}{d_o}$ as ordinates (scale $0.1\ \frac{d}{d_o} = 5$ cm.) and of x (scale 1 = 10 cm.) as abscissæ.

The following considerations may assist in making use of this curve. Assume that we have given Q, L and $P - p = l$ and hence also $R_o = \frac{r}{L}$. Knowing Q, we obtain from Table 1 the value of b, and further knowing $P - p$ we can obtain $p_m = \frac{P + p}{2}$ and hence w. Equation [12] gives then

$$d^5{}_o = \frac{1.251}{wR}Q^2\left(1 + \frac{q_o}{Q}\right) \qquad [18a]$$

Here, in the case of superheated steam, $q_o = 0$, while in the case of saturated steam with well-insulated piping, we may set $\frac{q_o}{Q} = 0.02$. Further, for $\Sigma k = 1$, we obtain from Equation [17] the value

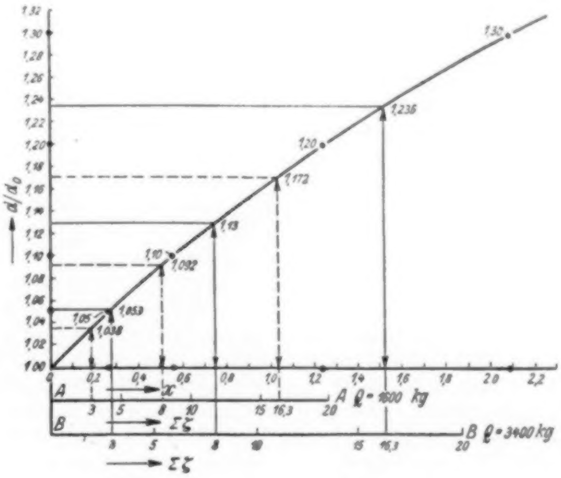

FIG. 2 CURVE SHOWING RATIO $\frac{d}{d_o}$ AS A FUNCTION OF $x = \frac{0.51}{bl}d_o\Sigma k$

(1,32; 1,3; etc. mean decimal fractions 1.32, 1.30, etc.)

$$x_{\Sigma k=1} = 0.51\frac{d_o}{bL} \qquad [19]$$

which may be used as a unit in dividing the axis of abscissæ in the curve shown in Fig. 2.

As an illustration of the foregoing we may use a numerical example in which the following values are given: $L = 0$ m.; $p = 9$ atmos.; $P = 9.6$ atmos., hence $p_m = 9.3$ atmos., and $w = 3.51$ kg. per sq. m.; $R_o = \frac{r}{L} = \frac{6000}{50} = 120$ kg. per sq. m. Required the pipe diameters for $\Sigma k = 3$, 8 and 16.3, respectively, these values corresponding to three different types of valves in the piping.

(*a*) $Q = 1600$ kg. per hr. According to Table 1, $b = 0.963$, and according to Equation [12]

$$d_o{}^5 = \frac{1.251 \times 0.963}{3.51 \times 120} = 1600^2$$

$$d_o = 5.947 \text{ cm} \qquad [20]$$

Further, from Equation [19] we have

$$x_{\Sigma k=1} = \frac{0.51 \times 5.947}{0.963 \times 50} = 0.0633 \qquad [21]$$

and hence, if we select as a scale of abscissæ $x = 1 = 10$ cm., the scale for the new axis of k indicated as $A - A$ and located below and parallel to the original axis of abscissæ will be

$$\Sigma k = 0.0633 \times 10 = 0.633 \text{ cm.} = 1 \qquad [22]$$

Similarly other abscissæ may be located.

With this subdivision of the axis of $k\,(A - A)$, the following ordinates of the curve are found for the respective values of abscissæ:

$$\Sigma k = 3\ \frac{d}{d_o} = 1.038, \text{ hence } d = 1.038 \times 5.947 = 6.15 \text{ cm.}$$

$$\Sigma k = 8\ \frac{d}{d_o} = 1.092, \text{ hence } d = 1.092 \times 5.947 = 6.84 \text{ cm.}$$

$$\Sigma k = 16.3\ \frac{d}{d_o} = 1.172, \text{ hence } d = 1.172 \times 5.947 = 6.96 \text{ cm.}$$

A similar example is worked out for $Q = 3400$ kg. per hr., which does not materially differ from the preceding one. (*Zeitschrift für Dampfkessel und Maschinenbetrieb*, vol. 44, no. 26, July 1, 1921, pp. 201–204, 2 figs., *pa*)

Short Abstracts of the Month

AERONAUTICS

German War Aeronautical Motors

Evolution of German Aeronautical Motors During the War, Capt. Harlaut. The evolution of the aeronautical motor in Germany was governed by the following three facts: first, unanimous opinion of German engineers that aeronautical motors should have 6 cylinders, arranged in a straight line and water-cooled; second, the appearance in 1916 of the Hispano-Suiza motor; and third, the search from 1917 for a motor of constant power, and simultaneously the study of variable-speed propellers.

Because of the shortage of raw materials the early German motors were inferior to motors of the Allies from the point of view of weight per horsepower and maintenance, which led the German administration to prescribe very stringent acceptance conditions for their motors. Not being able to secure the advantage of superior lightness, they sought to compensate for it by increase of power.

In 1916 a special effort was made to increase the output per unit, Daimler trying to achieve it by the increase in the number of cylinders from 6 to 8 in straight line, and Benz by an increase in piston displacement. A demand for still greater power output was brought about in 1917 by the need of large motors for bombing planes, the power output per unit reaching as high as 260 hp.

By the winter of 1917–18 pursuit planes, such as the Spad, brought about the demand for still more powerful engines. The Benz-4 type was too heavy, but the experience with the Maybach 260-hp. motor showed that a very material improvement in the power of a motor might be brought out by an increase in piston displacement and of compression obtained at a cost of a slight increase in weight. The Bavarian Motor Works were given the task of redesigning the 160-hp. Mercedes (D-III), which led to the development of the B.M.W.-IIIa, 185-hp. motor.

The demand of bombing planes for motors of 500 to 600 hp. led to many unsuccessful attempts on the part of the German designers. The B.M.W. built a 6-cyl., 180 × 180-mm. (7.2 × 7.2 in.) which at 1300 r.p.m. developed from 300 to 400 hp. The power proved to be insufficient and overheating developed.

Benz tried the use of cylinders 225 by 300 mm. (9 × 12 in.) with six valves and four spark plugs per cylinder and pressure oil cooling of cast-iron pistons. At 1400 r.p.m. the engine developed 623 hp., but the crankcase broke on account of vibration and the cooling of the pistons proved to be unsatisfactory.

Maybach succeeded in increasing materially the power output by simply adding a flywheel weighing about 50 kg. (110 lb.), using the same 6-cyl. engine with four valves per cylinder and a compression ratio of 6.07. Notwithstanding the presence of the flywheel, however, the vibration proved to be such as to endanger the crankcase.

Daimler succeeded in developing the 260-hp. Mercedes type into a motor giving 650 hp. at 1250 r.p.m. and weighing only 1050 kg. (about 2300 lb.), but the vibrations were such as to cause fracture of the crankcase.

On the whole, therefore, the German attempts to develop a high-power aeronautical motor prior to the Armistice proved to be a failure. Not being able to do so in an engine of a small number of cylinders, they tried to increase the number of cylinders, Daimler employing as many as 18. The only motors of this character were the Benz 500-hp. Bz-VI and superinduced Bz-VIv, the first developing 500 hp. and the other up to 675 hp. at peak load. It was the only high-powered type used by the Germans and consisted practically of two of the standard Benz motors V-coupled.

The appearance of the Hispano-Suiza motor produced a tremendous impression on German engineers by showing them the value of the V-type motors. Out of a number of types developed along the same lines as the Hispano-Suiza only the Benz and the Körting were accepted by the military authorities. Benz built an 8-cyl. motor giving 214 hp. at 719 revolutions, or 200 hp. at 1400 revolutions, no gear reduction being used at this latter speed.

The Körting motor is remarkable for its short length and compactness. It is also an 8-cylinder V-type, 110-mm. bore, 140-mm. stroke, with four valves per cylinder, running at twice the speed of the propeller, and developing 183.5 hp. at 2110 r.p.m.

On the whole, however, the development of the V-type motor was not of material assistance in the war. By the time it was completed (beginning of 1918) the motors no longer answered the demands of the day and a further step was made by Körting in developing a 12-cyl. motor and by Benz in the Bz-V, 145-mm. bore 160-mm. stroke, developing at 1500 r.p.m. as high as 450 hp. In the general scheme, the motor did not differ from the other Benz motors, namely, individual steel cylinders with cast-iron liners and sheet-iron water jackets autogenously welded, aluminum pistons, double magneto ignition and separate carburetors for each group of three cylinders.

It is notable, however, that many refinements were made permitting the reduction of weight and greater compactness of design. The four carburetors and the dynamo are placed inside of the V. A single camshaft is used, with three valves per cylinder, and a triple gear-driven lubrication pump and a gear reduction along the lines similar to those used by the Rolls-Royce concern but differing in some of the minor details. (First installment of a series, *L'Aeronautique*, vol. 3, no. 27, Aug. 1921, pp. 310–315, 10 figs., *d*)

AIR ENGINEERING

Experiments on the Effects of Extremely High Pressures, T. W. Bridgman. Data of an investigation in a field of which comparatively little is known, but in which the author has been working for several years. The author states that he worked with pressures as high as 20,000 atmos. or about 300,000 lb. per sq. in. (roughly ten times as high as the explosion pressure in a large gun).

Such tremendous pressures are obtained by the use of a patented device which is said to be absolutely free of leak as long as the steel containing vessel is itself strong enough to withstand it.

In the course of this work the author found that the engineering theories of the strength of vessels do not hold good at these high pressures. A cylinder will stand much more pressure than it is ordinarily credited with, and will also stretch a good deal more than the ordinary tensile test would suggest. When it breaks the crack starts on the outside where the stretch and stress are presumably least, and travels toward the inside where they are expected to be greatest.

Pressure was produced by a small piston driven by a hydraulic press operated by a hand pump. This pressure was transmitted through a connecting pipe drilled out of a solid bar. A modification of the dead-weight gage was used and as a secondary standard, one based on the change produced by pressure in the electrical resistance of a metal (manganin alloy).

In general it was found it is not possible to force ordinary liquid into the pores of a metal, even at the above high pressures. However, hydrogen compressed to a pressure of 10,000 atmos. will eat its way through a massive steel container and blow out. Compressed air apparently behaves in the same way, although at a slower rate, while mercury behaves much like hydrogen and can be forced through massive steel walls by about 60,000 atmos. pressure.

Under high pressure liquids were found to be comparatively highly compressible. By 12,000 atmos., water may be compressed to 20 per cent less than its normal volume, and even metals showed appreciable compressions.

Under sufficient pressure a liquid can be forced to freeze at temperatures substantially higher than its freezing temperature.

Ice produced under pressure of, say, 2000 atmos., is about 18 per cent less in volume per unit of weight than natural ice, and sinks instead of floating in water. Water at 180 deg. fahr. may be forced to freeze to this kind of ice by the application of about 20,000 atmos.

At 12,000 atmos. and 200 deg. cent. (923 deg. fahr.) phosphorus assumes a black form like graphite in appearance, loses its combustibility, becomes a conductor of electricity and is 50 per cent denser than yellow phosphorus. (*Compressed Air Magazine*, vol. 26, no. 9, Sept. 1921, pp. 10223-10225, 4 figs., *dA*)

BALLISTICS

The Study of Bomb Ballistics, H. L. Dryden. Description of recently developed methods for the study of ballistics of bombs launched from aircraft.

The early methods were rather crude; the more modern method is that in which the plane speed, altitude, and point of release of the bomb are determined by the use of two cameras obscura. In this method records are taken every second, and apparently reliable information is obtained regarding the trajectory of the bomb but not as to its oscillations or details of its behavior in the air. The method is used chiefly to secure approximate range data and probable dispersion due to all causes.

The second method for securing range data for bombs was worked out by Doctor Duff. A special bomb, with the source of light in the tail, was dropped at night and the part of the bomb was photographed by two cameras placed at the end of a measured base line and pointing at known angles to the horizon. From the trajectory of the cameras and the records on the plate the range may be computed.

Another method developed by Dr. F. C. Brown involves the study of bomb trajectories by means of moving pictures taken from the plane from which the bomb is dropped. If properly used, this method gives a great deal of information; for example, it permits the investigation of the oscillations of the bombs and likewise the behavior of the bombing plane. However, the method is difficult of application.

What promises to be an interesting method is the study of bomb ballistics by means of wind-tunnel measurement. Much valuable information has already been obtained in this way, and it is expected that ultimately it will be possible to predict, from wind-tunnel tests, the complete behavior of any proposed form of bomb. (*Army Ordnance*, vol. 2, no. 8, Sept.-Oct. 1921, pp. 83-85, 4 figs., *dc*)

ELECTRICAL ENGINEERING

Probable Limits of Electric Generators and Superpower Plants for Germany, Prof. W. Reichel. Discussion of the problem of the most economical and the largest commercially possible sizes of electric generators for central stations. The economy of large units is generally recognized and an interesting discussion is devoted to the question as to the largest commercially possible sizes.

The most advisable speeds for various sizes are given as:

3000 r.p.m. for generators up to 25,000 kva.
1500 r.p.m. for generators up to 40,000 kva.
1000 r.p.m. for generators up to 60,000 kva.

As examples of large generators two units are cited of 60,000 kva. at 1000 r.p.m. installed during the war in Germany. The diameter of the rotor is 2.25 m. (7.40 ft.) so that the peripheral velocity at 1000 r.p.m. is about 118 m. (387.1 ft.) per sec. Such large dimensions required a very powerfully built axle and also a design in which the critical speed was higher than the operating speed. As a matter of fact, the axle weighs 36 metric tons (39.1 short tons).

The author distinctly states, however, that theoretically it is by no means impossible to go considerably beyond 60,000 kva. for such generators. In fact, he says that it has been established by calculation that generators may be built in sizes up to 160,000 kva., and the most serious obstacle in the way of accomplishing such constructions lies in the difficulty of transportation of such huge machines by railroad, necessitating their assembling and, in particular, winding at the place of installation—an operation not always attractive.

General sketches are given showing the design of turbo-generators for an output of 160,000 kva. at 1000 r.p.m.

The use of such giant machines is suggested in a central station with six units, one being a standby. Such a plant would have a normal load of 400,000 kw. and a peak load of 500,000 kw., with a total output per year of, say, 2,000,000,000 kw-hr. Five such central stations would be sufficient to satisfy the entire demand for electric power in Germany.

For steam turbines to drive the 160,000-kva. generators the article suggests double units with steam admission in the middle, 16 to 17 atmos. pressure at the turbine inlet and 20 atmos. gage pressure on the boiler, with a steam temperature of 350 deg. cent. (662 deg. fahr.) at the turbine inlet valve.

In view of the great consumption of fuel and of water for condensation, it is obvious that such big plants should be located only near a large coal supply and also near a large river. Assuming coal delivered 300 days in the year, this would mean that 7500 tons per day would have to be received into the plant and be distributed either to the boiler rooms or to the bunkers.

The general conclusion to which the author comes is that at present the limit to the size of electrical generators is set mainly by the demand for power. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 35, August 27, 1921, pp. 1911-1917, 22 figs., *g*)

ENGINEERING MATERIALS

Rust Prevention by Slushing, Haakon Styri. Investigation of rust formation and prevention by slushing; of interest also because the experiments were conducted by exposure tests in humidors, similar to the method adopted by the U. S. Bureau of Mines in Pittsburgh. It was believed that if material in process could be protected from rust, cleaning before slushing would become possible.

Preliminary experiments have shown it necessary to use an aqueous washing liquid for the elimination of salts on the surface and for protection against action of the atmosphere. To do this, tests were made with washing in an emulsion of soap and mineral oil; it was expected that the aqueous solution would dissolve the salts and emulsify fats and fatty acids on the surface of the steel, and the oil particles would form a protective coating when they adhered to the surface.

Tests were made with the solutions either cold or boiling, the latter having been found preferable from the point of view of results. (Paper before the 40th Meeting of the *American Electrochemical Society*, Sept. 29-Oct. 1, 1921, abstracted from advance copy, pp. 113-128, *e*)

FUELS AND FIRING

Liquid Fuels in Internal-Combustion Engines

The Economical Utilization of Liquid Fuel, Carl A. Norman. An extensive discussion of the supplies of liquid fuel as they affect America, and their utilization in steam and internal-combustion engines. The author is Director of the Engineering Experiment Station, Ohio State University. Only a brief abstract of some parts of the investigation can be given.

The author states that the fuel situation is rendered unnecessarily complicated by trying to keep various fuel distillates apart and that a much better policy might be to mix them all together under a common name of distilled motor fuel. He advises that there are rumors that the oil industry has actually agreed on such a mixture as a standard motor fuel a few years from now.

The use of kerosene in automotive engines has been practically achieved for certain conditions, but the author considers it fortunate that no very determined efforts to adapt passenger cars and trucks for operation on kerosene have been made, because if this had been done the time would come when kerosene would sell at exactly the same price as gasoline. Indeed, the price of kerosene is now advancing much more rapidly than that of gasoline.

Passage of a Gas through a Throttle Valve. The throttling of a gas produces no temperature drop. The end temperature of compression should be the same in a throttled as in an unthrottled engine. If knock is relieved by throttling, then knock is dependent on the pressure attained rather than on the temperature.

Cooling by the Charge. The evaporation of the charge is capable of producing a cooling effect amounting to 50 or 60 deg. fahr. if the evaporation is complete. This cooling effect is naturally reduced by the imperfect evaporation of present-day fuels. It may be masked by heat from the engine parts. Experiments on a truck and tractor engine show it to be of quite the magnitude computed when the air heating is at its maximum.

Evaporation Temperatures of Liquid-Fuel Mixtures. Moisture will not condense out of atmospheric air, even if the temperature of the air is much below the boiling point of water under atmospheric pressure.

The amount of vapor that air can absorb and keep evaporated depends upon temperature of the air, pressure of the vapor in the air and boiling point of the vapor under this pressure.

A method is given to determine the amount of petroleum fuel that can be kept evaporated in air at various temperatures. It is found that for perfect evaporation of present-day gasoline a mixture temperature of about 110 to 130 deg. fahr. is necessary, while for kerosene the temperature must be raised somewhat over 200 deg. fahr.

Effect of Charge Heating on Engine Output. Charge heating reduces the ratio of the absolute temperature after combustion to the absolute temperature before combustion, and hence reduces the pressure rise.

Heat Development in Combustion Engines. The purpose of this article is to investigate the heat development with various mixtures. The nature of the chemical reactions is first discussed, and then the heat derivable from each one of the reactions ascertained.

Efficiencies Attainable in Internal-Combustion Engines. The maximum amount of work producible by a chemical reaction may be greater or less than the heat of reaction. In the case of combustion processes, it is in most cases very nearly equal to the heat of reaction. By utilizing the reaction in electrochemical primary batteries, very high factors of utilization may be attained and have experimentally been attained. If the enormous expansion ratios common in steam turbines were possible in internal-combustion engines, then this class of engines might also, in theory, turn perhaps 75 per cent of the heat energy into power.

As such expansions are not manageable with present types of engines, even ideally perfect engines of this kind could attain only very much lower heat utilizations. What these ideal standards are with actual fuels and actual combustion processes has been investigated on the theoretical side by Tizard and Pye, among others, and on the practical side by Ricardo, among others. A sample calculation of such an ideal efficiency is given.

These efficiencies are much lower than the so-called "air-standard" efficiencies. In fact, the margin of possible improvement of present-day engines at their best, is less than one might expect. For this reason, the desirability of maintaining a receptive attitude toward possible new types of prime movers is emphasized. (Bulletin No. 19 of the *Engineering Experiment Station, Ohio State University*, July 1921, 206 pp., illustr., *geA*)

Power Gas From Sewage

POWER GAS FROM SEWAGE, J. D. WATSON. Recent experiments at Birmingham, England, have shown that it is practical and economical to drive a suction-gas engine from gas derived from sewage sludge. Fig. 1 shows diagrammatically the experimental installation used at Birmingham. The pump installation comprises a 34-hp. horizontal gas engine of the ordinary suction type, a 5-in. diameter centrifugal sludge pump, and other parts as shown in the drawing. The gas holder indicated at *E* has not yet, however, been erected.

The engine is capable of giving 34 b.hp. at 250 r.p.m., with town gas having a heat value of 500 to 550 B.t.u. per cu. ft. In tests made with sewage gas from 27½ to 32 hp. maximum have been obtained. The principal constituents of sewage gas are methane, hydrogen, nitrogen and carbon dioxide, the percentage of marsh gas varying in the different places investigated in accordance with local conditions.

The volume of wet sludge dealt with at Birmingham is estimated at not less than 400,000 tons per year. The author estimates that from this sludge 9000 tons of dry solid matter are available to produce 320,000,000 cu. ft. of gas equal to 16,000,000 hp-hr., an equivalent of 4400 hp. per day of 10 hr. (Paper read before Section G of the British Association at Edinburgh, Sept. 14, 1921, abstracted through *Engineering*, vol. 112, no. 2908, Sept. 23, 1921, p. 456, 2 figs., *dA*)

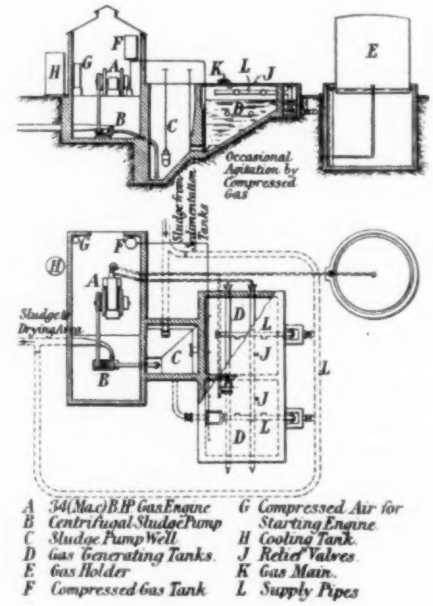

FIG. 1 EXPERIMENTAL INSTALLATION AT COLE HALL, BIRMINGHAM, TO UTILIZE POWER GAS FROM SEWAGE

HYDRAULIC ENGINEERING

SPEED REGULATION OF HYDRAULIC TURBINES, JOHN S. CARPENTER. Discussion of principles and methods of calculation involved in the design of hydraulic-turbine governors. The article is not suitable for abstracting, but is of considerable interest because it gives the calculations necessary to understand the design of governors, omitting, however, the part of the calculations employing higher analysis. Therefore, to those equipped with only an elementary knowledge of mathematics, it provides a suitable basis of presenting the questions involved in water-turbine governor design. (*Power Plant Engineering*, vol. 25, no. 19, Oct. 1, 1921, pp. 947–950, 1 fig., *gp*)

INTERNAL-COMBUSTION ENGINEERING (See also Aeronautics; Fuels; Marine Engineering)

DISTRIBUTION OF FRICTIONAL LOSSES IN INTERNAL-COMBUSTION ENGINES, E. P. Taylor. Data of tests carried out at the P. N. Russell School of Engineering in Australia. The tests were carried out by using the so-called retardation method on a 6-hp. Victor oil engine, 6-in. bore and 8-in. stroke.

The engine was of the vertical enclosed crankcase type, with plain bush bearings lubricated by the splash in the crankcase running through holes in the upper part of the bearings, the bearings being flooded by hand feeding. The engine was driven by a belt from an electric motor, a record being kept of the temperatures of the main bearings and cylinder.

In addition, two other engines were used, a National gas engine and a Crossley. The former was of the horizontal 4-stroke cycle, 11-in. bore and 19-in. stroke, only the temperature of the cylinder was observed, and the speed was attained by driving under gas in the ordinary way. The Crossley gas engine, was a 30-hp., 9½-in. bore and 18-in. stroke. The main tests were carried out on the Victor engine.

A detailed account is given of the retardation factors for various elements of the engine. The main data are assembled in Tables 1 and 2. From these tables it would appear that even with different types of engines there is such a general agreement in the percentage of friction allotted to each part that a general table showing

in round figures the average distribution of frictional losses, is justified. Limitations of the retardation method of testing are indicated. (Paper published in the Journal of Proceedings of the Royal Society of New South Wales, abstracted through *Gas and Oil Power*, vol. 16, no. 192, Sept. 1, 1921, pp. 190–192, *et*)

TABLE 1 COMPARISON OF DISTRIBUTION OF FRICTION IN VARIOUS INTERNAL-COMBUSTION ENGINES

Part of Engine	National 40-hp.	Crossley 30-hp.	Victor 6-hp.
Main bearings	15 per cent	16 per cent	11.5 per cent
Layshaft and valve gear	2	4	1.5
Gas friction	34	37	37
Connecting rod	4	3.5	5
Piston	45	40	45

TABLE 2 DISTRIBUTION OF FRICTION IN INTERNAL-COMBUSTION ENGINES

Part of Engine	Per cent Distribution
Piston	45
Gas friction	35
Main bearings	14
Connecting rod	4
Layshaft and valve gear	3

STILL OIL ENGINE FOR MARINE PROPULSION. Description of the Still oil engine (see MECHANICAL ENGINEERING, p. 627, 1919) constructed by the Scotts Shipbuilding and Engineering Co., Greenock, for use on shipboard, and tested by a deputation of engineers representing the French government and commercial interests.

The engine is said to be the largest of the type so far constructed and is of the low-speed marine type designed for merchant service. The Still engine is a combination of oil and steam engines. The main source of power is oil, consumed within a cylinder on the down stroke. The steam is generated in the cylinder jacket and forms a supplementary source of power used on the up stroke.

The present engine has a stroke of 36 in. and bore of 22 in. Efficiencies obtained in trials in May 1921 were: At full load, combustion i.hp. efficiency, 44.8 per cent; engine b.hp. efficiency, 39.4, net b.hp. efficiency, 37.7. At half load the respective efficiencies were 46.2, 38.5 and 35.8; at quarter load 46.1, 34 and 30.0. The total oil consumption per i.hp-hr. was found to be lower than in a good Diesel engine; at full load it was 0.360 lb. per b.hp-hr., at an overload of 11 per cent, 0.398 lb. per b.hp-hr. and at quarter load as high as 0.47 lb. (*Engineering*, vol. 112, no. 2905, Sept. 2, 1921, pp. 344–345, 2 figs., *eA*)

Piston-Temperature Measurements in Oil Engines

MEASUREMENTS OF TEMPERATURE IN THE PISTONS OF OIL ENGINES, Dr. Eng. W. Riehm. Description of methods developed for direct measurement of temperature of non-cooled pistons of Diesel engines under various operating conditions, and discussion

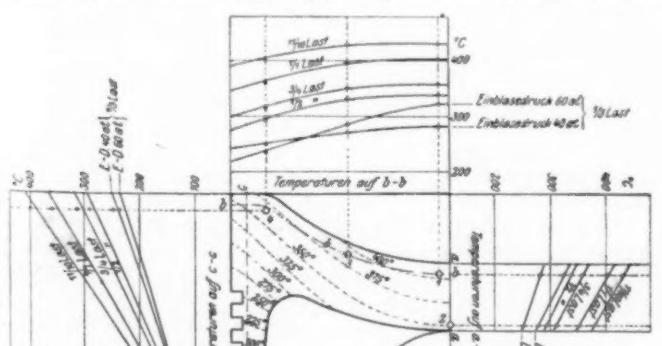

FIG. 2 TEMPERATURES IN PISTON BODY *A* AT VARIOUS LOADS (*Last*, load; *temperaturen auf*, temperatures along.)

of temperature distribution in pistons of various designs. The tests were made on an experimental unit developing 70 hp. at 165 r.p.m. and working with tar oil to which a lighter oil is added at small loads. The thermoelements consisted of base metals (iron-constantan and copper-constantan), and a special two-part piston was built to provide a convenient location for the thermocouples.

Figs. 2 and 3 give the temperature at various loads and at various air-injection pressures. In the upper part of the cylinder *B* the temperature lines are practically concentric to the axis of the piston, and the entire distribution in the body approaches that of a cylinder heated from the inside.

On the other hand, the piston body proper *A* shows a greater temperature difference between the center part and the rim and more approaches in character more the case of a plate heated in the middle. Also the maximum temperatures in the middle of the body are a good deal higher. These differences in temperature distribution are ascribed primarily to the fact that the heat is not transmitted throughout the body in a uniform manner, but is given mainly to the region where the fuel jet strikes with the higher temperature and greater velocity. Fig. 3 is of interest as showing the influence of air-injection pressure on the heat transmission and temperature distribution in the piston body.

The other parts of this interesting article cannot be abstracted owing to lack of space. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 35, Aug. 27, 1921, pp. 923–925, 7 figs., *e*)

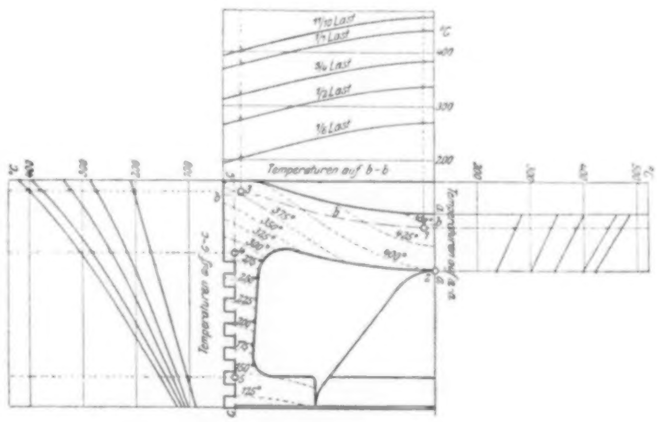

FIG. 3 TEMPERATURES IN PISTON BODY *B* AT VARIOUS LOADS AND AIR-INJECTION PRESSURES

(*Last*, load; *temperaturen auf*, temperatures along; *at.*, atmospheres; *Einblasedruck*, air-injection pressure; *E-D*, air-injection pressure.)

MACHINE DESIGN AND PARTS

Pipe Bends

RELATIVE VALUES OF TYPES OF BENDS AND HOW THEY MAY BE MOST EFFECTIVELY INSTALLED. In this article it is claimed that the assumption that the expansion U-bend is only twice as effective as a plain U-bend, is not correct. The derivation of an expression for the expansive value of an expansion U-bend is given.

The various kinds of bends are shown in Figs. 4, 5 and 6. In the bend in Fig. 5, the deflection at *P* is obtained in two steps—first, by considering the deflection in the length *XY*, assuming the outer leg *XP* to be rigid, and then considering the deflection in *XP* under the assumption that the portion *XY* is rigid.

It can be demonstrated by calculus that the horizontal component of the movement at *P* due to flexure of the bend in the portion *XY* is

$$\frac{a^3P}{EI}\left(\frac{3\pi}{4}+2\right) \qquad [1]$$

and that the corresponding movement at *P* due to flexure in the portion *XP* is

$$\frac{a^3P}{EI}\left(\frac{3\pi}{4}-2\right) \qquad [2]$$

Adding [1] and [2] and multiplying by 2 for both halves of the bend, we have $D = 3\pi a^3P \div EI$. But for the condition of maximum fiber stress, $P = SI \div ad$. Substituting this value of P, we get

$$D = \frac{3\pi a^2S}{Ed} \qquad [3]$$

which represents the total deflection of an expansion U-bend in one direction from the normal or unstrained position. The deflection of a plain U-bend may be found in the same manner to be

$$D = \frac{\pi a^2 S}{Ed} \quad \ldots\ldots\ldots\ldots\ldots\ldots [4]$$

which represents the deflection of a plain U-bend one way from the normal or unstrained position. It is thus seen that if the effect of the short tangents necessary at the ends of pipe bends for installing the flanges is neglected, the expansive value of an expansion U-bend, as shown in Fig. 4, is three times that of a

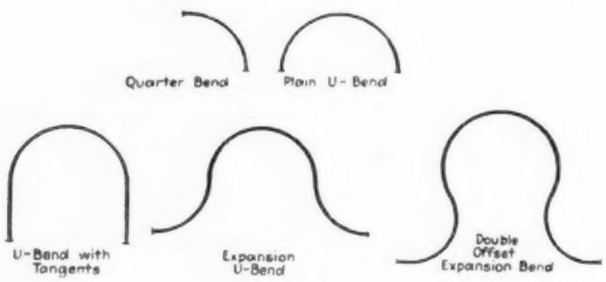

FIG. 4

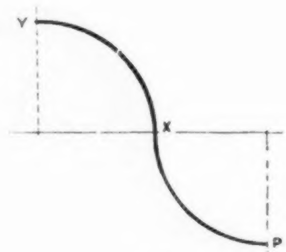

FIG. 5

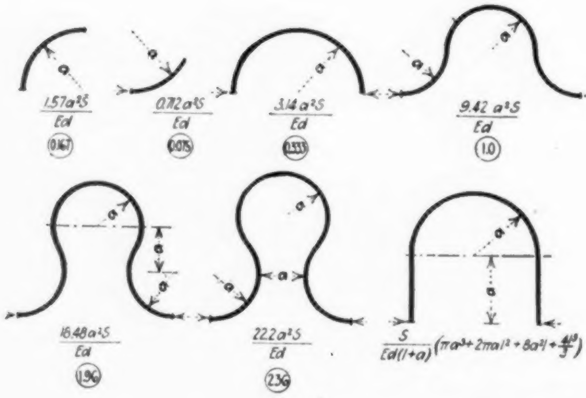

FIG. 6

FIGS. 4, 5 AND 6 PIPE BENDS FOR EXPANSION IN PIPE LINE

plain U-bend with the same radius, using the same size of pipe. The expansive value is seen to be independent of the thickness of the walls of the pipe, an extra heavy bend having the same capacity as a bend made from standard-weight pipe. This is true, however, only in case the effect of the internal steam pressure is neglected. For bends composed entirely of circular arcs the allowable deflection is proportional to the square of the radius for a given maximum fiber stress, where

D = expansive value of the bend either way from the normal or unstrained position
a = mean radius of bend in inches
d = outside diameter of pipe in inches
M = bending moment
E = modulus of elasticity of the material
I = moment of inertia of a cross-section of the pipe
P = thrust in lb.
S = maximum fiber stress, lb. per sq. in.

The expansive value of a quarter bend depends upon the way it is installed in the line. The formulas for different bends are given in Fig. 6, the expansion being one way from the normal or unstrained position. From Fig. 7 the allowable expansion for any of the bends shown can be obtained by using the relative value factors shown in Fig. 6. (*Power*, vol. 53, no. 19, May 10, 1921, pp. 742–743, 4 figs., *p*)

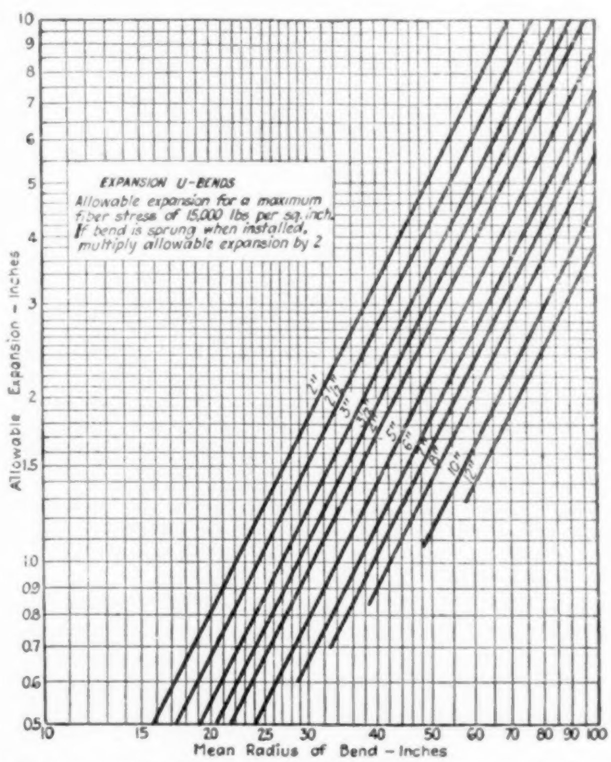

FIG. 7 CHART FOR DETERMINING ALLOWABLE EXPANSION IN PIPE BENDS

MARINE ENGINEERING (See also Internal-Combustion Engines)

TURBO-ELECTRIC PROPULSION. Rumors persist in British engineering circles that one of the four new battle cruisers of this year's naval program is to be fitted with turbo-electric propulsion. An editorial points out that British Admiralty engineers have very little actual experience on the subject beyond that gathered from foreign sources—in particular, from America.

Concerning this latter, it is stated that the U. S. Navy Department exhibited extraordinary boldness in passing directly from the New Mexico type (24,000 kw.) to battleships of 60,000 and cruisers of 180,000 shaft hp. The latter are to be propelled by four shafts, and the application of motors of 45,000 hp. to each will be a noteworthy feat.

The editorial does not recognize the validity of claims made for electric driving. Instead it claims that with mechanical gearing there is a greater flexibility of speed than with electric transmission, as the latter must rotate at revolutions which suit the number of cycles employed while the former may run at any odd number.

Certain alleged disadvantages of the electric system are also pointed out, such as lower economy at all except very low powers, considerably greater weight and more complexity by the full extent of the system of electrical control, the steam element remaining practically as before. It is also stated that experience of small merchant vessels with turbo-electric propulsion has been anything but satisfactory in some cases, though a number of vessels in the United States are to be fitted with it. (Editorial in *The Engineer*, vol. 132, no. 3428, Sept. 9, 1921, p. 267, *g*)

British Motor Tanker and Its Engines

THE MOTOR TANKER "CONDE DE CHURRUCA." Description of a twin-screw oil tanker recently launched at the works of Sir W. G. Armstrong, Whitworth and Company. It is propelled by

two 1250-b.hp. Armstrong-Sulzer engines, representing the most recent type of design and also being the largest engines of this type which have up to the present been fitted in a British mercantile vessel.

The deck machinery, consisting of the anchor windlass, winches, and derricks, is all steam-driven, the steam being raised in an oil-fired donkey boiler which also provides steam for the heating coils in the cargo and fuel tanks.

The engines each develop 1250 b hp. at 100 r.p.m. in four cylinders, 600 mm. bore and 900 mm. stroke. They are equipped with the Sulzer rotary sleeve valve (Fig. 8) which controls the admission of scavenge air to the cylinder. The correct position of this valve is determined for ahead and astern by a simple loose eccentric worked from the operating gear.

The starting and reversing mechanisms are so interlocked that no false start can be made. During the trials it was shown that each engine could be started and stopped twelve times consecutively without replenishing the starting receivers, of which there are eight, each of 800 liters capacity. In addition to the high-pressure receivers, there is a low-pressure receiver supplied through a reducing valve. This receiver provides air service for the service motors for the operating gear and the turning gear, and also for the air-driven lubricating-oil priming pump and the whistle.

The piston is cooled by a spray, sea water being used as the cooling medium. During the war an experiment was made to test the effect of heat stress on the delicate parts of the engine. The test engine was overloaded till the exhaust pipe was heated to redness and collapsed. When the engine was opened up the piston rings were intact and the lubrication was unimpaired, owing to the efficiency of the cooling system. The piston itself is made in two sections. The crown is only about 44 mm. thick, and is supported by five buttresses of special shape which allow the piston to take up its own position when the heat stresses come on. The piston

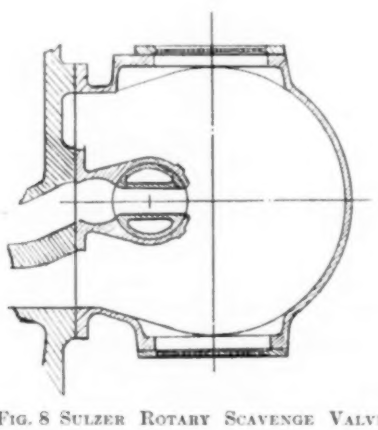

Fig. 8 Sulzer Rotary Scavenge Valve

rod is so joined to the body that the piston is free to expand radially, and it is claimed that sticking is entirely eliminated.

All control mechanism is grouped on the top platform in full sight of the valve-gear and fuel-pump mechanism. However, this is optional and the makers are also prepared to fit auxiliary control on the lower platform. The starting valve is operated by a mechanical device, so constructed that it can be readily removed and examined. This makes it possible for the engineer to assure himself that the maneuvering gear is in good working order.

Of the auxiliaries attention is called to the Hele-Shaw electric steering gear, and the combined compressor and generator built by Sulzer Brothers to be used for emergency purposes. The latter consists of a two-stage air compressor delivering air at 1200 lb. per sq. in. driven by a 12-hp. hand-started hot-bulb engine, which is also coupled to an 8-kw. 110-volt emergency generator.

The two engines, with flywheels, pumps and all fittings, weigh about 330 tons. (*The Engineer*, vol. 132, no. 3429, Sept. 16, 1921, pp. 297–301, illustrated, *d*)

MECHANICS (See Internal-Combustion Engineering)

MISCELLANEA

The Alignment Chart, C. W. Crockett. Presentation of a basis for the construction of alignment charts and a method interpreting charts. Alignment charts lend themselves to the graphical representation of mathematical relations of many kinds and may save a great deal of calculation work.

The article is of a strictly mathematical character and not suitable for abstracting. As an example, a chart is given by which one may determine the diameter of the wire and the mean diameter of the coil of a helical spring formed of round steel wire if the amount of compression and extension, the maximum load, and the solid height are given, and also determine the extreme fiber stress under that load. (*Automotive Industries*, vol. 45, no. 13, Sept. 29, 1921, pp. 614–618, 5 figs., *pg*)

MOTOR-CAR ENGINEERING

Brotherhood 5-Ton Steam Wagon. Description of a steam truck of British manufacture which is unusual in some respects. The boiler is of a type which has about double the heating surface usual in steam wagons. It is of a type, too, in which the smokebox doors at each end are utilized as chambers for the exhaust steam, which thence escapes through small nozzles along the upper tubes of the central combustion chamber at the base of the chimney. In the present design each smokebox door has six exhaust nozzles

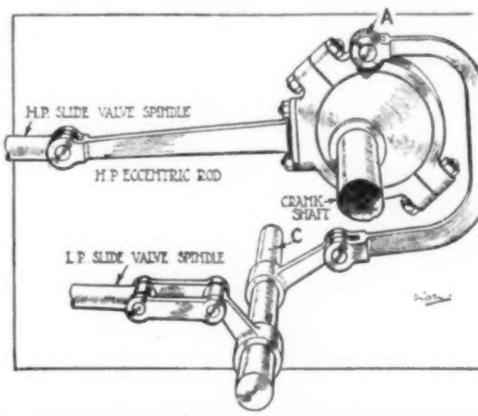

Fig. 9 Valve Gear of the Steam Engine in the Brotherhood Steam Wagon

discharging through a single row of large tubes. Incidentally, each exhaust pipe is formed with a trap for condensation. By disposing of the exhaust steam by this method, it is obvious that a steadier and gentler draft is possible. Consequently, the type affords an easy steamer, requires little or no forcing, and pulls its fire about but little. The water level is less affected on steep gradients than in any other design. The fusible plug can be fixed 8 in. to 9 in. below the water line, and so the risk of burning it out is very remote.

The engine motion is such that the D-slide valves of both high- and low-pressure cylinders in both forward and reverse directions are operated off a single eccentric. The principle of this motion is as follows: The cranks of the two cylinders are at right angles to each other. The eccentric works the high-pressure valve direct and at a point 90 deg. further round (to correspond with the position of the low-pressure crank), the eccentric strap carries a lug A, whence a link B transmits this motion to a rocker shaft C, off which the low-pressure valve is actuated. The whole arrangement is best seen in Fig. 9. Incidentally, this is the only undertype steam wagon employing a compound engine. (*Motor Transport*, vol. 33, no. 863, Sept. 12, 1921, pp. 277–279, 9 figs., *d*)

MUNITIONS (See Ballistics)

POWER-PLANT ENGINEERING (See also Electrical Engineering; Machine Design and Parts)

Electrically Operated Speed Governor for Traveling Grates

Speed Governor for Traveling Grates, Generlich. Description of a device built by Bosselmann, of Berlin, Germany,

engineer (Fig. 10). In this the factor governing the speed of progression of the grate through an electrical transmission is the temperature of the cooling water on the wiper. The principle of this device is that with a constant supply of cooling water, its temperature will be the higher the nearer the flame part on the grate approaches the wiper, which means the more poorly the coal is burned.

Referring to Fig. 11, the wiper consists of an iron plate 10 mm. (0.4 in.) thick and a water-cooled body made up of a T- and L-iron shapes properly bent and welded together.

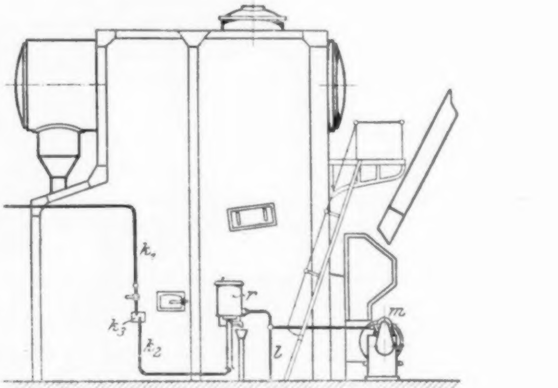

Fig. 10 Traveling Grate-Speed Governor
(k_1 cooling water inlet; k_2 cooling water outlet; l lead to motor starter; m motor; r speed governor.)

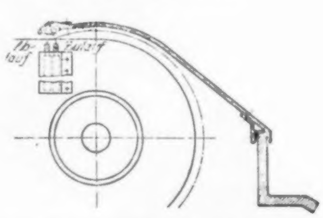

Fig. 11 Wiper with Water-Cooled Body
(*Zulauf*, water inlet; *Ablauf*, water outlet.)

The cooling water flows first to the chamber at the rear and then through that located toward the grate. The thin walls transmit well the heat to the cooling water, the temperature of which may vary between 40 and 70 deg. cent. (104 to 158 deg. fahr.).

In the unit tested by the author the wipers on a double grate have been in use for four months without showing any material signs of wear or requiring any repairs.

The most important part of the governor itself is the Samson expansion device, Fig. 12. This consists of a tube *a* filled with glycerine, in which is located a metal hose *b* and a piston with piston rod *c*. The governor is inserted into the second tube *d*, through which passes the wiper cooling water. The heat from the cooling water is transmitted to the glycerine. To make the piston stroke as great as possible, the metal hose *b* is given the length of 1 m. (39.37 in.) and its elongation per deg. cent. of rise of temperature is 1 mm. (0.02 in. per deg. fahr). To the piston rod *c* is connected the bridge *e* carrying 12 vessels *f* filled with mercury and arranged so that into these vessels may dip corresponding graduated contacts *g*.

These contacts in their turn are so arranged as to short-circuit in 13 stages the resistance inserted in series with the armature of the motor driving the grate, the entire resistance being short-circuited when all the contacts dip into the mercury, which happens when the cooling water is cold. On the other hand, when all the contacts are out of the mercury, which happens when the cooling-water temperature is high, then the entire resistance is in series. In this way the cooling-water temperature is enabled to govern the voltage on, and hence the rotation of, the motor within wide limits. To prevent sparking at the withdrawal of the contacts from the mercury and also the evaporation of the mercury, a thin layer of paraffin is spread over the surface of the mercury.

The author of the present article carried out some tests on this device in the boiler room of the Osram Co. in Berlin, and found that the voltage and speed of the motor were quite closely governed by the temperature of the water, being, for example, 220 and 1500 respectively at water temperature of 47 deg. cent., 70 and 480 at 67 deg. cent., etc.

The installation apparently requires only one additional valve in the water-cooling system, this valve having a permanent setting for each plant and each given set of operating conditions. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 36, Sept. 3, 1921, pp. 943-944, 5 figs., *d*)

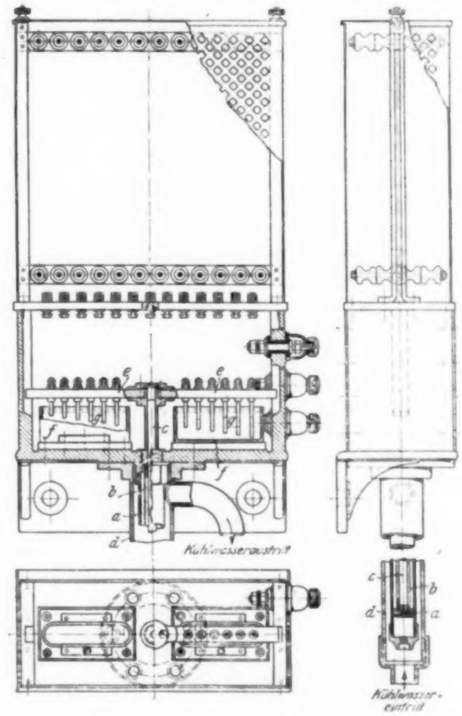

Fig. 12 Traveling-Grate Speed Governor with Samson Expansion Device
(*Kühlwasseraustritt*, water outlet; *Kühlwassereintritt*, water inlet.)

PRIME MOVERS (See Steam Engineering)

STEAM ENGINEERING (See also Internal-Combustion Engines; Motor-Car Engineering)

A Closed-Cycle Ammonia Motor

Closed-Cycle Ammonia Motor, Prof. E. Garuffa. Many attempts have been made to produce a "steam" engine employing a liquid vaporizing at a lower temperature than water, and there are numerous patents on such engines, none of which, however, have reached a stage of commercial development.

Of such engines the ammonia motor originally developed by an Italian engineer, B. Caruso, possesses certain features of interest. In this engine an attempt is made to utilize to a very high degree the latent heat of the exhaust vapor, which has never been successfully accomplished in steam engines. The thermal properties of ammonia are claimed to be such as to permit this utilization of latent heat to a greater extent than is possible with water.

The closed cycle operates essentially as follows: In the first place, there is a generator of saturated ammonia vapor doing work in a proper motor (e.g., a turbine) and constantly fed from another generator connected to it. In this second generator the exhaust vapor from the turbine gives up its heat to the liquid, and being condensed to a liquid state goes into an automatic feeder which delivers it to this second generator. Theoretically, under this cycle the only heat that has to be supplied to the ammonia in order to maintain the cycle is the heat corresponding to the work done and the heat necessary to compensate for losses—in particular, those which are not recuperated either before or after condensation. While at the same pressure, which is the maximum pressure of the cycle, the two generators which constitute the fundamental

part of the system are, however, at different temperatures, the difference in temperature being the temperature head across the turbine.

Fig. 13 illustrates the manner of actually effecting this cycle. A is a receiver or really a vapor generator heated by some fuel; M is the turbine or other kind of motor which receives the vapor from the ammonia generator after it has passed through the superheater S_A, the purpose of which is to utilize the heat in the exhaust from the furnace in the generator A. At B is a tank of liquid ammonia acting as a surface condenser; into it is immersed the coil S receiving the exhaust vapor from the turbine and condensing it. The condensate collects in the receiver C, whence it is conveyed by the pump P' to E, which, in its turn, constitutes an automatic feature of the condenser B, the latter acting as the second vapor generator.

The respective positions of the two units, A and B, (which, as has been stated above, act as two vapor generators at different temperatures) are such that they act as two communicating vessels (by pipe P) in such a manner that with equal pressures the levels of the liquid are the same.

Further, between the tank B and the dome D is inserted a special diaphragm d, and between the tank B and generator A another diaphragm R. These diaphragms permit the establishment of a uniform pressure throughout D, B and A, this being the maximum pressure of the cycle, at the same time maintaining between A and D and D and B the temperature head necessary for the motor to function.

The vapor which collects in D from surface evaporation of the liquid in B is in a state of saturation due to its being in contact with the liquid and at a fixed temperature which may vary between 60 and 100 deg. cent. in accordance with the existing pressure. It is conveyed by the pump E as saturated vapor, into the generator A and from there, together with the vapor generated therein, is sent on its way first to the superheater S_A and eventually to the turbine M.

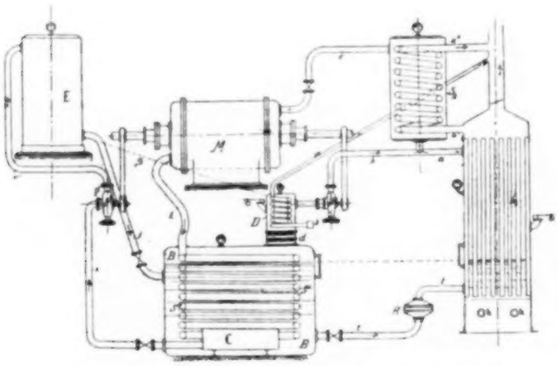

FIG. 13 CARUSO CLOSED-CYCLE AMMONIA MOTOR

The purpose of the dome D is to maintain the liquid in B at a constant temperature, preventing the liquefaction of saturated vapor contained therein. To do this the dome is provided with a heating device which may or may not be connected with the furnace in A, and the heat coming therefrom helps to maintain the saturated vapor at a temperature of saturation corresponding to the maximum pressure of the cycle, 24 atmos. for 60 deg. and 60 atmos. for 100 deg. cent.

It is claimed that the efficiency of such a system is quite high. The heat content of a kilogram of superheated vapor Q is the sum of the heat content q of the saturated vapor and the superheat in the vapor, the latter being

$$q_1 = c_p\ (t_{\text{sup}} - t_{\text{sat}})$$

and hence the theoretical quantity G of steam per horsepower-hour in kilograms is

$$G = \frac{632}{Q} = \frac{632}{q + c_p\ (t_{\text{sup}} - t_{\text{sat}})}$$

(t_{sup} = temperature superheated vapor; t_{sat} = temperature saturated vapor). The actual quantity will be considerably greater, because of the losses in the turbine, generator and condenser, and imperfect efficiencies of these units. Assuming that the heat losses are 10 per cent, efficiency of generator is 75 per cent, efficiency of turbine 70 per cent and efficiency of condenser 85 per cent, we get a total efficiency of 40 per cent and a consumption equal to 2.5 Q.

No statement is made as to whether any such engine has ever been built, and, if it has, what were the actual results of tests on it.

In his work on the ammonia motor Caruso worked out experimentally the following tables of physical quantities of ammonia.

TABLE 3 PRESSURE IN AMMONIA VAPOR AS FUNCTION OF TEMPERATURE

Temperature deg. cent.	Atmos.	Temperature deg. cent.	Atmos.	Temperature deg. cent.	Atmos.
— 20	1.84	+ 5	5.07	50	19.94
— 15	2.29	10	6.07	60	24.32
— 10	2.83	15	7.21	70	32.45
— 5	3.46	20	8.51	80	40.60
0	4.20	30	11.62	90	50.15
		40	15.49	100	61.30

TABLE 4 HEAT OF VAPORIZATION OF AMMONIA IN CALORIES AT VARIOUS TEMPERATURES

(Amount of Heat Absorbed by 1 kg. of Liquid Producing Its Vaporization at Temperature t at a Pressure of Dry Saturated Steam at that Temperature.)

Temp. t deg. cent.	Calories	Temp. t deg. cent.	Calories	Temp. t deg. cent.	Calories
— 20	327	+ 5	311	50	275
— 15	324	10	308	60	273
— 10	322	15	305	70	268
— 5	319	20	301	80	264
0	315	30	292	90	260
		40	283	100	255

TABLE 5 HEAT NECESSARY TO RAISE THE LIQUID (ANHYDROUS AMMONIA) FROM ZERO TO t DEG.

Temp. t deg. cent.	Calories	Temp. t deg. cent.	Calories	Temp. t deg. cent.	Calories
— 20	17.34	+ 5	4.45	50	51
— 15	18.13	10	9.17	60	63
— 10	8.83	15	14.87	70	75
— 5	4.47	20	19.66	80	88
0	....	30	29.49	90	105
		40	39.64	100	120

TABLE 6 TOTAL HEAT OF VAPORIZATION OF AMMONIA

(Sum of the Heats of Tables 4 and 5.)

Temp. t deg. cent.	Calories	Temp. t deg. cent.	Calories	Temp. t deg. cent.	Calories
—20	344.34	+ 5	315.45	50	326
—15	337.13	10	317.17	60	336
—10	330.83	15	319.87	70	343
— 5	323.47	20	320.66	80	352
0	......	20	321.49	90	365
		40	322.64	100	375

TABLE 7 SPECIFIC VOLUMES OF SATURATED AND DRY AMMONIA VAPOR

Temp. t deg. cent.		Temp. t deg. cent.		Temp. t deg. cent.	
—20	0.646	+ 5	0.250	50	0.073
—15	0.525	10	0.221	60	0.051
—10	0.432	15	0.183	70	0.037
— 5	0.358	20	0.161	80	0.025
0	0.298	30	0.122	90	0.018
		40	0.090	100	0.013

(*L'Industria*, vol. 35, no. 14, July 31, 1921, pp. 312–314, 2 figs., *de*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

Corncobs and Their Uses

Only a few years ago the farmers in the corn belt of the United States considered corncobs as useless and undesirable refuse. They used them for fuel, but only when wood or coal was scarce.

Recently many important uses have been found for the corncob, which is no longer allowed to go to waste. Cellulose, which is the principal component of the corncob, is employed in the manufacture of various explosives.

From corncob pulp certain grades of paper may be made, and a valuable substance, furfural, may be obtained which is used in the manufacture of certain adhesives and forms the basis of a beautiful green dyestuff for silk. It is also an important reagent in the chemical laboratory. (*Steam*, vol. 28, no. 4, October 1921, p. 97.)

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which, in the opinion of the investigators, do not warrant a paper.

Apparatus and Instruments A9-21. Ring Gage Measurements. The Bureau of Standards is using three balls of the same diameter at 120 deg. apart with a fourth ball resting on them for the purpose of measuring ring gages. A method of governing contact pressure on the precision balls is being devised. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A12-21. Colorless Waterproofing. A preliminary report is being issued on the results of six months' exposure to weather of materials treated with 19 different waterproofing compounds showing also the appearance when applied to light-colored stones. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A13-21. Foreign Specifications for Portland Cement. A chart 16 x 22 in. has been issued by the Bureau of Standards showing the principal physical and chemical requirements of portland cement as required by specifications of various countries. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fire Prevention A1-21. Report 2262 by A. C. Fieldner and S. H. Katz to the Bureau of Mines is on the Gases Produced by the Use of Carbon Tetrachloride and Foamite Fire Extinguishers in Mines. These extinguishers were obtained in the open market. The fluid in one consisted mainly of carbon tetrachloride and small quantities of other substances to prevent freezing. The foamite extinguishers contain a solution of aluminum sulphate in a central cylindrical tube and a sodium carbonate liquor solution in the annular space around the tube. When the two liquids mix CO_2 is produced and this throws a foamy liquid stream through a nozzle for 30 or 40 ft. The tests were made in an experimental mine belonging to the Bureau.

A wood fire was kindled and after this was freely burning an attempt was made to extinguish it, six men with extinguishers being ready for this work. Extinguishers were used one after another until the fire was put out. Samples of gas were taken into vacuum tubes at different distances from the fire. The results are given in the table below:

Distance from fire	Phosgene, parts per million	Hydrogen chloride, p.p.m.	Chlorine, p.p.m.	Carbon dioxide, per cent	Oxygen, per cent	Carbon Monoxide, per cent	Methane, per cent	Nitrogen, per cent
5	30	180	0	0.39	20.52	0.18	0.01	78.90
25	..	150	0	0.43	20.47	0.16	0.03	78.91
45	90	...	0	0.53	20.37	0.15	0.03	78.92
75	20	250	0	3.05	17.80	0.31	0.01	78.83

The foamite tests produce no dangerous gases although sufficient carbon monoxide was present to cause severe headache and nausea. The tetrachloride produced in addition to the tetrachloride vapor hydrochloric acid of from 150 to 255 parts per million and phosgene from 20 to 90 parts per million. Military authorities consider 25 parts per million of phosgene sufficient to produce death in 30 minutes. Hence care must be taken in using the tetrachloride extinguishers in underground fire fighting. They are not used for extinguishing fires in and around electrical equipment because the tetrachloride is a non-conductor of electricity. In small closed rooms it is dangerous to use this extinguisher. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Fuels, Gas, Tar and Coke A15-21. Shale Oil. Report No. 2254 on the Nature of Shale Oil Obtained from Assay Retort and Report No. 2256 on the Oil-Shale Industry deal with data regarding oil shale particularly from the Rocky Mountain District. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Fuels, Gas, Tar and Coke A1-21. Steaming in Vertical Gas Retorts. The first section of the Fuel Research Board of Great Britain for the years 1920-21 has just been issued. This section is on Steaming in Vertical Gas Retorts. The heading scovered are as follows:

Program of tests
General description of plant
Conditions under which test were made
Test for determination of heat losses from setting
Description of coals used
Description of carbonizing tests

General Remarks:
- "Heat Equivalent" of the setting at the Fuel Research Station
- General observation on tests
- Thermal efficiency of carbonization
- Behavior of steam in the retorts
- Economic and practical limits of steaming
- Suggestions for consideration on practical points
- Application of graphs to any individual setting
- "Heat Equivalent" for any individual setting.

The report may be obtained at 1s.6d. from the Imperial House, Kingsway, London, WC2.

Gases, General A1-21. Pressure-Volume Deviation of Methane, Ethane, Propane and Carbon Dioxide at Elevated Pressures. G. A. Burroughs and G. W. Jones have worked on pressure-volume relations in a manner described in Technical Papers 131 and 158 of the Bureau of Mines. Methane produced by fractional distillation of natural gas at low temperatures and pressures, ethane produced by the electrolysis of sodium acetate, propane by the action of propyl iodide on a zinc copper couple and carbon dioxide produced by sulphuric acid on a solution of potassium carbonate were used. Care was taken to rid all of impurities. Fractional distillation at low pressures and temperatures was used for final purification. Starting with a pressure of 80 mm. with a correction of 0.1 per cent, the correction for the product Pv at 31,000 mm. was 12.5 per cent for CH_4. For ethane the correction at 23,000 mm. was 37.7 per cent, for propane at 5723 mm. 10.6 per cent and for carbon dioxide at 26,500 mm. the correction was 22.2 per cent. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Hydraulics A3-21. Flow in Riveted Steel Pipe. Bulletin No. 8 of the Engineering Experiment Station, Purdue University reports the investigation of the flow of water through galvanized spiral riveted steel pipe of diameters of 4 in., 6 in., 8 in., and 10 in. The Bulletin is by Prof. F. W. Greve and R. R. Martin. The friction drop was determined in 40 ft. of pipe and velocities varied from less than 2 ft. per sec. to over 20 ft. per sec. Experiments showed that the loss in head could be expressed by the equation

$$h_1 = m(v)^n$$

where v = velocity in ft. per sec.
h_1 = loss of head in ft.

The value of n is about 1.9 and the value of m varies with the diameter of pipe; n also varies slightly with the diameter of pipe. When the flow is against the laps the following relations hold for n and m:

$$n = -0.877\ d^2 + 0.832d + 1728$$
$$m = 0.0515/d^{0.926}$$

When the flow is with the laps the following hold:

$$n = -1.954\ d^3 + 2.166\ d^2 - 0.464d + 1.845$$
$$m = 0.0488/d^{0.799}$$

The values of f in the equation

$$h = \frac{f\,l}{d}\ \frac{v^2}{2g}$$

was found to vary with the velocity of flow and the size of pipe. The Bulletin gives tabulated values of this factor. The experiments show that when the flow is with the laps the resistance is practically the same as for clean cast-iron pipe. Engineering Experiment Station, Purdue University. Address A. A. Potter, Director.

Metallurgy and Metallography A16-21. Tensile Properties of Steel at High Temperatures. The investigation made at the Bureau of Standards on the test of alloyed steels at elevated temperatures will be presented at the September Convention of the American Society for Steel Treating under the title Tensile Properties of Some Structural Alloy Steels at High Temperatures. Four steels containing about 0.40 per cent carbon were tested at various temperatures between 20 deg. cent. and 550 deg. cent. The samples were of four kinds:

(*a*) Plain carbon steel; (*b*) 3½ per cent nickel steel; (*c*) steel containing 3 per cent nickel and 1 per cent chromium; (*d*) steel containing 1 per cent chromium and 0.2 per cent vanadium. The steel containing chromium showed a greater resistance to weakening by increase of temperature to about 550 deg. cent. than either of the other two steels. At high temperatures chromium-vanadium steel is preferred from the standpoint of high tensile strength and limit of proportionality. The carbon and the 3½ per cent nickel steels behave in a similar manner so that the nickel appears to have no effect. The report also refers to the type of fractures obtained in testing these steels at various temperatures. Typical microphotographs are included. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A17-21. EFFECT OF HEAT TREATMENT ON MECHANICAL PROPERTIES OF CERTAIN STEELS. A report of tests made at the Bureau of Standards on heat-treated carbon-molybdenum and chromium-molybdenum steels will be presented at the September Convention of the American Society for Steel Treating. The following results are obtained on a steel containing 0.20 per cent carbon and 1 per cent molybdenum:

1 For each maximum temperature there is a critical rate of cooling which will lower Ar_1. The higher the temperature the slower is the rate of cooling to produce the lower transformation. By whatever combination this is produced the position of the low point is fixed within a narrow temperature range to about 525 deg. cent. Rapid cooling will suppress this point.

2 A high temperature transformation is observed slightly above and almost merging with Ar_3 when the steel is cooled from temperatures at or above 960 deg. cent. at a rate of approximately 0.15 deg. cent. per sec. At a faster rate this is not observed.

3 Ar_2 is fixed at about 760 deg. cent. independent of maximum temperature of heating or rate of cooling.

4 The most suitable temperature from which to harden this steel is in the neighborhood of about 910 deg. cent. Free ferrite is found after quenching from 830 deg. cent. but the observed changes in mechanical properties with rise in quenching temperature within this range cannot be explained by known changes in carbon or iron, by differences in the rate at which the steel passes through the critical ranges resulting from changes in initial temperature of cooling, by unsatisfactory hardening or by the lowered Ar_1 for they are opposite to the changes found in plain carbon steel under similar conditions.

5 For the production of definite tensile strength, water quenching is preferred on account of the higher proportional limit, ductility and impact values, and hence better tensile properties are obtained for a given impact resistance.

6 Raising the quenching temperature from 910 to 980 deg. cent. does not materially alter mechanical properties when subsequently tempered at a relatively high temperature of 540 deg. cent.

Steel containing 0.27 per cent carbon, 0.9 per cent chromium, 0.5 per cent molybdenum give the following results:

1 The Ar_1 transformation is first split and lowered when cooled from 960 deg. cent. or 1000 deg. cent. at about 0.15 deg. cent. per sec. The low point is observed at 480 deg. cent. In water quenching from the highest temperature a lower hardness is obtained than when similarly cooled from 960 deg. cent. In this respect chromium-molybdenum steel behaves similarly to the molybdenum steel except that the changes are produced from higher temperatures.

2 In normalizing the chromium-molybdenum steel a low limit of proportionality and impact resistance are obtained when using temperatures above 780 deg. to 845 deg. cent.

3 The fact that no material changes in tensile or impact properties are produced by oil quenching the chromium-molybdenum steel from a wide range of temperatures when subsequently tempered at 540 deg. cent. has been confirmed. To produce high impact values in the hardened steel a tempering temperature in the neighborhood of 650 deg. cent. is required. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Petroleum, Asphalt and Wood Products A7-21. Fourth Semi-Annular Motor Gasoline Survey of the Bureau of Mines shows a drop of seven cents in the cost per gallon from the previous year with an increase of more than 380,000 gal. in the first five months of 1921 over the similar period of 1920, the total amount handled being over two billion gal. The 115 samples showed the specific gravity of 0.747, the same as last year, with distillation temperature practically the same as last year, the average boiling point being 268 for 1920 and 269 for 1921. The per cent recovered was 96.6 for 1921 and 96.7 for 1920. The distillation curve falls slightly below the 1920 average which was below the Federal Specifications. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Wood Products A9-21. GLUE FOR DAMP PLACES. Casein glues are so water-resistant that plywood glued with them will stand exposure to warm damp atmospheres for many months while animal and vegetable glues will resist such atmosphere a very short time. After a long time the water-resistant glue loses its strength due to the hydrolysis of the casein brought about by sodium hydroxide. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products A10-21. DRY KILNS. Progressive dry kilns consume less heat per lb. of water evaporated and reach highest heat efficiency in drying from green state, especially when supplied continuously with green lumber of one thickness and class. Compartment type of kiln is more flexible and affords greater control over drying conditions, giving more constant temperature, humidity and circulation with variation in wind and weather. It is fitted to meet varying requirements of different materials and is useful where exact and careful drying is required. Forest Products Laboratory, Madison, Wis. Address Director.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Mechanics B6-21. FATIGUE OF MATERIALS. The first step of the investigation by Prof. H. F. Moore and others on the fatigue of materials is nearly completed and a bulletin is in preparation. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Mechanics B7-21. UNSYMMETRICAL SECTIONS. The action of angles, channels and other unsymmetrical sections in relation to tension and bending is to be investigated by Prof. A. N. Talbot. The study will be made by obtaining strain-gage measurements at various portions of the piece when subjected to load. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Properties of Engineering Materials B3-21. TENSILE PROPERTIES OF STEELS AT HIGH TEMPERATURES. The investigation of the properties of low-carbon steel used in boiler construction has been completed and the results prepared for publication. These will be presented under the title: Effect of Temperature, Deformation and Rate of Loading on the Tensile Properties of Low-Carbon Steel below the Thermal Critical Range, by H. J. French. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Railway Rolling Stock and Accessories B3-21. CHILLED CAR WHEELS. The experiments directed by Prof. J. N. Snodgrass and conducted by H. F. Goldner are almost complete. The investigation of the properties of chilled car wheels was undertaken to determine the strains arising from the mounting of the wheel on its axis, the strains resulting from the static or wheel loads, the strains resulting from the flange pressure, the ultimate breaking strength of the wheel flanges and the strains due to the temperature gradients in the wheels as caused by brake application. In making the experiments, the load was applied as nearly as possible in the same manner as the application in service; the strains were measured by the Berry strain gage and the data obtained from the tests were considered in relation to the material, design and other features of the car wheel. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

C—RESEARCH PROBLEMS

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

E—RESEARCH PERSONNEL

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

C. B. Roberts Engineering Company E1-21. The C. B. Roberts Engineering Company has equipped a laboratory for investigating petroleum problems on commercial-size samples. The company is preparing to handle all phases of oil-refinery developments, to make petroleum analysis and process work, to design refineries and prepare estimates for the same, to construct and operate refineries and to make report on betterment work and appraisal as well as do research work of a general nature. Address C. B. Roberts Engineering Co., 19 Milk St., Boston, Mass.

F—BIBLIOGRAPHIES

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Petroleum, Asphalt and Wood Products F5-21. Serial 2269 of the Reports of Investigations of the Bureau of Mines contains a list of recent articles on Petroleum and Allied Substances compiled by E. H. Burroughs. These bibliographies are prepared monthly. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

Supplementary Reading for Consulting Engineers

The January, February and May 1921 issues of MECHANICAL ENGINEERING contained correspondence concerning a list of books for supplementary reading by students in industrial management. In connection with this discussion there has been received a list arranged by The Thompson & Lichtner Co., consulting engineers, of Boston, Mass., designed to familiarize its men with existing literature on subjects of particular interest to them.

This list contains the following group of ten books which are to be read in the order given and reviewed:

- How to Use Your Mind, Kitson
- Industrial Leadership, Gantt
- Primer of Scientific Management, Gilbreth
- Scientific Management, Drury
- Theory and Practice of Scientific Management, Thompson
- Shop Management, Taylor
- Work, Wages and Profits, Gantt
- Scientific Management and Labor, Hoxie
- Administration of Industrial Enterprises, Jones
- Industrial Organization and Management, Diemer.

Supplementary lists on the following subjects are given, from which each man may choose according to his needs:

- Production
- Sales
- Industrial Relations
- Accounting
- Construction
- Plant and Lighting
- General.

The Engineer's Part in Fire Protection

TO THE EDITOR:

Now that the production-at-any-cost engineer of wartimes has been superseded by the economical-production engineer, the questions of violation of the various rules of fire prevention and safety should be taken up and the effect of such violations shown.

Practically every class of engineering is affected by the degree of consideration given these questions. The architect or engineer who designed the building which was fire-resistive except for unprotected steel roof members, placed a lasting insurance charge on that building at a saving in construction cost which would have been covered in a five-year period by the difference in insurance rates.

This difference in cost of insurance is illustrated by several plants where so-called temporary ordinary-joisted brick or frame additions were built on to fire-resistive or slow-burning buildings, without fire divisions between the two sections. For instance, a fire-resistive building of the finest type had first a 300-ft. joisted-brick addition, then another 300-ft. joisted-brick addition, and finally a 150-ft. frame addition, making a total length of about 1750 ft. in one fire area. The original building would have rated at not exceeding 20 cents per hundred insurance, but now the entire building rates at \$1.50, and in view of the fact that this particular building and contents is valued at about \$6,000,000, the cost of this mistake is approximately \$78,000 a year; three fire walls across these buildings at \$5000 each would have given a rate of about 90 cents, or a saving of \$36,000 a year.

The buildings of the war period have also given the highest record of losses in sprinklered risk resulting from additions which were built and not equipped with sprinkler protection. Records of insurance companies show that 22 per cent of their sprinklered-risk losses are due to fires started in unsprinklered areas not cut off by fire walls from the sprinklered areas.

Going into the matter of protection, we have a sad record of losses resulting from poor placing of fire hydrants, generally too close to buildings, and insufficient number of fire hydrants as a whole. There have also been numerous cases of protection systems which have not been equipped with adequate water supplies, mainly through lack of sufficient reserve pumps.

Many production engineers consider that the man who sends the finished material to the loading dock is the only really important factor in the plant, disregarding entirely the maintenance engineer, who keeps the plant in condition so that it may produce, and the fire-prevention and protection engineer, who keeps it in existence. The fire-prevention or protection engineer and the safety engineer are generally placed on the non-productive payroll, whereas the proper organization for any plant is to have the maintenance, the fire-prevention, and the safety engineer either on an equal with the production engineer, or closely associated with him.

The average fire loss per capita in the United States has not been below \$3 in the last 10 years and was about \$5 for the year 1920. This is a national overhead which of course affects all factors of production. We have also the overhead cost resulting from accidents causing decreased efficiency, decreased production and increased labor turnover. The reduction of these overhead costs depends to a great extent on the knowledge and efforts of the architect, the designing engineer, and the construction engineer, and their coöperation with the man who has specialized in fire prevention and protection, and with the safety engineer.

Detroit, Mich. W. M. WELLS.

The Fuel Situation

TO THE EDITOR:

The possibilities along the line of natural gas, fuel oil, city gas, producer gas, both raw and clean, as well as powdered coal and stokers for furnace heating, are known by only a limited number, and the activities of The American Society of Mechanical Engineers could be broadened to cover various kinds of fuel through the whole range of their application.

Natural gas is fast disappearing and cannot be considered as an industrial fuel. Even today many industries that were built around natural gas are forced to look for some other fuel to replace it. Due to the cheapness of this fuel little or no thought was given to its economical application, and many instances may still be found where furnaces are very inefficient. Fuel oil, raw gas, clean gas, powdered coal and stokers have all replaced in a greater or less degree some of the natural gas with good results, but only in a few instances have the highest, or anywhere near the highest, possible economies been obtained.

Fuel oil, because of its price and the ease with which high temperatures may be obtained, has been widely used. We know, however, that our fuel-oil supply is getting shorter every year, and there are very few shops in the country where fuel oil is used that much attempt has been made to economize on the fuel in any other way than by burner design. Where high temperatures are desired such furnaces run with flames issuing from the vents and doors. Often furnaces of this kind run with hearth temperatures of 800 to 1000 deg. above that required by the metal itself, and no thought is given to a better product to be obtained by other methods without decreasing the production. Fuel oil in low-temperature work is very wasteful, as used at present, because of the excess of air that is normally used to hold the temperatures down.

City gas becomes out of the question in most cases because of the necessarily high price of this fuel.

Raw gas has done much to reduce the cost of manufacture and increase the overall efficiency of furnace application, but there are few installations other than the open-hearth that receive the attention they should.

Clean gas has made some strides in fuel economy for furnace application and it must not be confused with the gas-power proposition.

Because of the fact that the flame temperature of clean producer gas is lower than that of many other fuels, it has been necessary to apply some effort to reach desired results with this gas, but that effort has always paid in the increased economies that may be obtained.

Powdered coal has shown very good economies in many plants, and the work is of such a late date and has received so much publicity that not much need be said for this method of fuel economy.

Stokers have been used for a number of years on various kinds of furnace work, and the best results obtained were in instances where the stoker and furnace were taken as a whole.

The whole point is that the fuel economies possible in all fuels are so great that increased efficiencies of 25 to 30 per cent can be obtained, rather than a few per cent under boilers. No one of the fuels now used is a cure for all ills, each having a certain field of application, but by getting together on this subject we can determine wherein added economies may be obtained and what is the best method of fuel application for various kinds of work.

Dayton, Ohio. EARL E. ADAMS.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Below are given the interpretations of the Committee in Cases Nos. 357 to 363 inclusive, as formulated at the meeting of June 23, 1921, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

CASE No. 357

Inquiry: Are the circulating pipes connecting down-draft furnaces to the shells of boilers to be considered as integral parts of the boilers themselves or as connecting piping outside of the boiler? Screwed connections as now used give both economy in space and flexibility.

Reply: It is the opinion of the Committee that such connections between boiler shells and down-draft furnaces are integral parts of the boiler, so that the requirements in Par. 268 for pipe openings leading from a boiler need not be met, and screwed connections may be used. The requirement for the minimum number of threads given in Table 8 applies to all pipe connections and should be met, as well as all other requirements which bear on the structure.

CASE No. 358

Inquiry: Is it permissible, under the requirements of the Boiler Code, to deliver feedwater into the shell of a boiler through what is known as an induction valve or spray nozzle located in the steam space and arranged to deliver the water through a number of constricted openings in the form of a spray?

Reply: It is the opinion of the Committee that such an arrangement at the end of the feed pipe for delivery of the feedwater to the boiler will not meet the requirement of Par. 314, which requires that the feed pipe shall have an open end or ends to prevent stoppage by incrustation, unless the combined area of the passageways for the flow of the water is at least equal to the area of the feed pipe and these passageways are so arranged that it will be impossible for them to become clogged by incrustation.

CASE No. 359

Inquiry: Is it permissible, under the requirements of the Boiler Code, with heads stayed by through rods, to attach the rod ends to the heads by a special form of gland nuts that provide for packing between them, as shown in Fig. 18?

Reply: It is the opinion of the Boiler Code Committee that this construction does not conflict with the requirements of the Boiler Code, provided that the area of the nut bearing surface against the plate is greater than the minimum cross-sectional area of the rod. The value of C for this construction shall be 135.

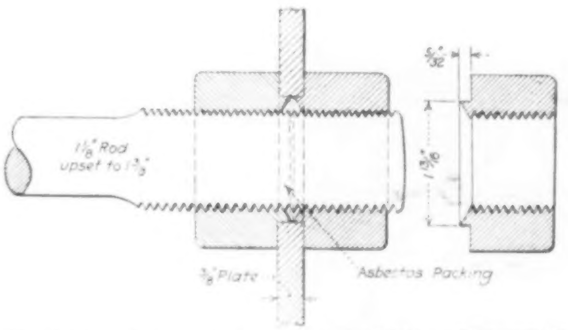

FIG. 18 SPECIAL FORM OF GLAND NUTS FOR ENDS OF THROUGH RODS

CASE No. 360

Inquiry: Is it necessary, under Par. 254, to remove heads, open up girth seams and remove manhole frames, braces, etc., in order to remove burrs formed by drilling or reaming of rivet holes?

Reply: Par. 254 refers specifically to the plates and butt straps at longitudinal joints.

CASE No. 361

(Annulled)

CASE No. 362

Inquiry: (*a*) What is the minimum thickness of plates used for dome heads that is permitted under the requirements of the A.S.M.E. Boiler Code?

(*b*) Is it permissible to stay the heads of domes, where they are flat, by using angle or channel irons?

Reply: (*a*) There is no limit specified in the Code for the minimum thickness of dome heads except as given in Par. 17.

(*b*) The heads of domes, if flat, shall be stayed in accordance with Pars. 199 to 233 inclusive.

CASE No. 363

Inquiry: Is it permissible, under the requirements of the Boiler Code, to apply a manhole in the upper head of an h.r.t. boiler over 40 in. in diameter, the area of the head surrounding the manhole to be stayed as provided in Pars. 203*e*, 214 and others applying to stayed surfaces?

Reply: In accordance with Par. 264, a manhole shall be placed in the upper part of the boiler shell, boiler head or dome head, of a fire-tube boiler over 40 in. in diameter. When applied to the head of such a boiler, the head shall be stayed in accordance with Par. 203*e*.

Impressions of Industrial Russia

Glimpses of the Workers and Factories in Moscow and Petrograd—The Present Economic Situation and the Doubtful Outlook for Russian Industries

By ROYAL R. KEELY, NEW YORK, N. Y.

The position of Russia in European reconstruction is of vital interest to American engineers and industrial executives, and there is lack of reliable information as to conditions in Russia. Mr. Royal R. Keely, Mem. Am.Soc.M.E., returned from nearly two years in Russia, as this issue of MECHANICAL ENGINEERING was about to go to press. Upon being convinced of American interest in Russian developments, he prepared this statement of some of his impressions. Coming from an engineer and an experienced observer in industrial plants, it will be accorded authority.

Mr. Keely is a graduate of Cornell University in electrical engineering and received the degree of M.M.E. in 1901. After three years' experience in power-plant and electrical railway machinery, he served as professor of engineering at the University of South Dakota for two years, as consulting engineer in Sioux Falls, South Dakota for one year, and as city engineer of Edmonton, Alberta, N.W.T., Canada, from 1906 to 1909. Since that time he has acted as professor of electrical engineering at the Nova Scotia Technical College, consulting engineer for the Tabor Mfg. Co., Philadelphia, and in 1913 he opened an office as consulting management engineer.

Mr. Keely went to Russia in 1919 and for eight months visited the industrial plants in and about Moscow. He was imprisoned for a year and upon his release he had a four-months' opportunity to observe the operation of the industries of Russia.—EDITOR.

ROYAL R. KEELY

THE Bolshevik revolution came in Russia in October 1917. I arrived in Moscow on September 18, 1919, so their organization plans and methods of industrial operation had had ample opportunity to get well under way.

The general plan of the Bolsheviki is that of wholesale centralization. There are various departments such as the departments of state, war, and education. "Means of Production and Ways of Communication" are handled by the department known under the name of the Supreme Council of National Economy.

The Metal Department with Ludwig Martens, former Bolshevik agent in this country, at its head, includes all metal-producing and working plants. One division of this department is devoted to standardization, and groups of engineers are attempting to establish ideal standards for screw threads, bolts and nuts, and chemical and physical standards for iron, steel and alloys. They also propose the standardization of an ideal form of the automobile, locomotive, etc., as a step in simplifying and standardizing manufacturing.

If Russian industries were completely destroyed and the present régime had the power to build everything anew, then a plan of standardization might be practiced. The average Russian thinks that the problem is 99 per cent solved after these idealistic fantasies are drawn up. The details necessary for effective execution are entirely ignored. When elaborate electrification plans were worked out for entire Russia, the work was looked upon as substantially ended. Electric plows are devices which cannot be of value in Russia for some generations. Yet a considerable number of engineers, clerks and stenographers are wasting immeasureable time on their development.

There are two important reasons for these fantastic schemes. One is that the simple-minded officials are pleased by these elaborate scientific projects and encourage the work. The other reason is that every individual in Russia is assigned to a particular job, from which he cannot move without official permit. Therefore engineers, scientists, and educated people find it necessary to create jobs. It is more interesting for them to work out these elaborate theoretical plans than it is to clean streets or split wood.

Central Stores Department

In the organization of industry, one particularly interesting and theoretically fine department called the "Producemet" has been set up. This corresponds in our practice to a general stores department. Here are recorded the location, quality and quantity of all raw materials in the entire nation, also the quantity and kind of finished product and its location. The records for all manufactured products are turned into this office automatically, as well as all demands for them. Under the Bolshevik scheme, each individual is to work for the government, and in return for this service he is to be supplied with the necessities of life. If one wants a typewriter he puts in his demand at the central stores department, where they decide whether he is entitled to a typewriter. If his request is granted, the machine is ordered to be shipped from the nearest point of production or storage. In the the central office is a very elaborate and complicated card system, but the staff is entirely incompetent and untrained and the records are never up to date and are entirely unreliable. In the winter of 1920 I visited this department. There were about 2000 employees, but at the time of my visit it was extremely cold, the temperature in the rooms being around the freezing point. Only a very small fraction of the total number of employees were at their desks, a few typists attempting to write on their machines with gloved hands.

The Professional Unions

The professional or trade unions are attempting to take an important part both in the educational and industrial control. The government is theoretically a government of the workers and peasants. These professional unions are therefore a part of the government and are consequently under the control of the Bolshevik party. They fix the rates of pay and also the piece rates and premiums. Their plan has been the establishment of a fixed base rate which varies according to the production and general efficiency of the workers. Bonuses for increased production have been ineffective because of the extremely difficult working conditions. There is always the demand for increase of wages, and with each increase of wages the cost of living goes up in approximately the same proportion. It is interesting to note that the market price on food, clothing and daily necessities remains about constant as compared with the American dollar. The value of the ruble drops in proportion to the increase in wages.

The workmen have their Soviets in each factory. These men, illiterate and inexperienced in executive and technical work, have power over the engineers and members of the old technical staff. This fact, in connection with the shortage of raw material, fuel, instruments and tools, makes any effective result almost unthinkable.

For any degree of success from such a gigantic centralized organization for production and transportation it would require a nation of able, honest and efficient people, all unselfishly working for the public good. Graft and corruption were proverbial under the old régime in Russia, and under the new, the adverse economic conditions have greatly increased dishonesty and thievery.

Street Railways and Telephones

The official working hours are from 10 to 5, but scarcely any one in Moscow works longer than from 11 to 4. The entire evenings are spent in repairing shoes, sawing and splitting wood, carrying water, removing ashes, and running to various departments for food rations from the government. In the winter of 1919–20 the street-car system did not operate. Last summer and winter there was a limited street-car service, but only certain employees who were able to secure official passes were allowed to ride. The telephone service is almost entirely destroyed. All telephones have been removed from private apartments.

Discontent among Employees

With the whole of Russia reduced to a state of starvation, it is painful to see great cities like Moscow and Petrograd without any useful productive effort. I was surprised to see the general discontent among all employees. The average man is only interested in making a job for himself to comply with the compulsory labor requirements. Every one in Russia who has any education, training or ability wants to leave the country, and would if the opportunity was given. I had rather a close acquaintance with the Russian-American Tool Company, made up of a few Russian immigrants to America who had a little coöperative factory here in the United States. In 1918 their patriotism led them to return to Russia, taking their American machinery and equipment with them. They established a tool factory in Moscow in the fall of 1919 which is looked upon as a most successful example of the new industry, although its production is only one-tenth of what it should be. I renewed my acquaintance with these men in the summer of this year, just before leaving Moscow. They are all extremely dissatisfied with their experience in Russia. The employees receive one and a half Russian pounds of black bread daily, a little soup for their noon lunch, and once a month four or five pounds of meat, some vegetables and fish. This is better than the workers in other factories get. Also their pay is better. Yet these men are selling their personal effects in order to provide daily necessities, and this was in the summer when the living conditions were easier. They did not dare consider the difficulties of the coming winter.

I have seen and talked personally with hundreds who returned to Russia under the patriotic impulse. I have not found a case where they were not making every effort to get back to America.

Conditions in Moscow Factories

The big Goujon factory, devoted to structural steel, wire rope, etc., and employing some six or seven thousand men before the revolution has now but a thousand employees. The old technical men who are trying to direct the work have very great difficulties. They are short of raw material, fuel, food, trained workers, etc. They have no control of discipline. I asked the chief engineer to tell me the greatest need of his plant, and he replied, "A proprietor."

The AMO automobile factory is a new plant with the very finest buildings and American equipment. Six or seven thousand men should be employed for full operation. They now have about 1000 employees, and these are engaged in trying to complete the plant, which was not entirely ready when the revolution came, and in repairing a few automobiles. Their output is about what would be expected from an American garage of 15 or 20 men. They tried all the winter of 1919–20 to make a cylinder casting for a White motor truck. In May 1920, after dozens of experiments, they had one casting which they failed to machine.

The International Harvester Company's factory near Moscow is the only factory I found which had not been "nationalized," but even here the manager's hands were tied, because for all the essentials of manufacturing he must depend on the Bolshevik government. He takes his orders from the Bolshevik government and manufactures on a cost plus 10 per cent basis, out of which he must pay his expenses and those of the executive staff. He permitted the Workmen's Committee to have charge of social matters, sanitation, hospitals, food, etc., but technical questions are decided by the technical staff. By his energy and tact he has maintained discipline and achieved some success. The government failed to supply this plant with fuel. They then allowed the manager to take a train of cars to the forests and bring back the necessary wood. For his furnaces he required coal and coke. Rickoff, president of the Supreme Economical Council, said to him, "We cannot get this coal for you. We will give you a train and you can go for the fuel yourself." The manager took the train to the mines under a soldier convoy, and came back with enough fuel to keep the furnaces going for the immediate future.

Locomotive Repairing

At one time I told Lomonossoff[1] that the fate of his country hung primarily on transport, and that transport, in turn, depended on locomotive repair. Orders were subsequently issued and locomotives were placed in all sorts of factories which lacked equipment or workmen for this kind of work, and any appearance of regular production was thereby destroyed. The men were given a bonus when a locomotive was repaired and they were allowed to go to the country and bring in food. This brought about the most inefficient results. The locomotive was turned out quickly, making a good record for the factory, but would come back shortly for another repair. At the time of the revolution there was a big wire cable factory near Moscow. Here, for several months, about 1000 men were employed getting the plant ready. In the spring of 1920 the first locomotive was completed and the men took this engine with a train of cars and went several hundred miles into the country for food, disrupting any scheme of transportation schedules.

During all this time, the big locomotive works in Russia were standing idle!

Petrograd Factories

Bad as the manufacturing conditions are in Moscow, the prospects there are better than in any other part of Russia. In Petrograd the big Tregolnik Rubber Company plant employing 38,000 men before the revolution is entirely idle. In the Baltic Shipbuilding Plant only a little repair work is being done. At the time Petrograd was threatened by the opponents of the Bolsheviki a large part of the machinery was evacuated from Petrograd, but the machines were taken apart without being marked and so "scrambled" that it was entirely impossible to reassemble them again. The Siemens-Schuckert Works, employing about 40,000 men is now essentially idle, doing only a little repairing. In the Arthur Koppel plant in Petrograd regular production was stopped, and at the time of my visit early in 1920 they were making only a few turf-excavating machines.

Classes in Russia

The whole population of the present Soviet Russia may be divided into five classes. The first includes what one may call the political idealists and these have been instrumental in laying out the general organization plan for the present government. Their number is very small. The second class is made up of a few hundred who are now ruling with an iron hand. These men are living better than they have ever lived before, occupying the best houses, having the best food and clothing and the use of automobiles. The third class comprises the remainder of the Bolshevik membership, said to number about 500,000, most of whom are not in sympathy with the party. Finding their families cold, hungry and ill clad, and seeing their Bolshevik friends better situated, they join the party. The fourth class includes the peasants, the majority of whom may be said to be strongly against the present régime. The fifth class includes former wealthy people, the educated groups, professors, scientists and engineers. It seems to be the aim of the Bolsheviki to exterminate this class. Therefore their living conditions are extremely bad. The Bolsheviki have been successful in only one thing and that is in pulling every one down to the level of the lowest of prerevolutionary times. The only exceptions to this are the first two classes named above.

Position and Problems of Engineers

The position of the engineer in Russia today under the Bolshevik régime is exceedingly difficult. Conditions do not permit constructive work by engineers.

I can refer to a great many instances where engineers of my acquaintance are procuring enough food and fuel for their families only by selling their books and instruments. They are living huddled in squalid quarters, doing their cooking on small sheet-iron stoves which also serve as heaters. They carry supplies up five or six flights of stairs, after hauling them miles from the storehouse. They are occupying minor clerical jobs in the factories or government offices to get their food allotment, or are doing menial mechanical work in smaller villages where food and fuel conditions are slightly better. The chief engineer of the AMO automobile works was theoretically in charge of production. This

(Continued on page 764)

[1] Formerly foreign representative for the Kerensky government in the purchase of railway material. At present acting in a similar capacity for the Bolshevik government.

MECHANICAL ENGINEERING

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C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

The Relation of the Engineer to Public Utilities

M. E. COOLEY

DR. PRITCHETT, President of the Carnegie Foundation, says in his recent report on the law profession:

> If organized society is to continue, the great mass of human beings who compose it must be fed and clothed and warmed and transported.

Mr. H. G. F. Spurrell, in Modern Man and his Forerunners, defines civilization as:

> . . . . . the mode of life in a territory which is maintaining a larger population than could live on the land if the people were not organized to develop its resources.

Spurrell's "civilization" under modern conditions becomes Pritchett's "organized society."

On the walls of the Engineering Societies Library one may read that:

> Engineering is the art of organizing and directing men, and of controlling the forces and materials of Nature for the benefit of the human race.

Thus we see that engineering is a factor in civilization—so important a factor, indeed, that modern civilization, as we know it, could not exist without engineering. That is to say, if the work of the engineer were to be wiped out of existence—annihilated—desolation would fall upon cities and adversity sweep the land. Civilized people would be pursued by famine and plague, suffering and sorrow being in proportion to their degree of culture and refinement. Only those living close to nature would be unaffected.

But more specifically what part does the engineer perform in Dr. Pritchett's conditions for the continuation of organized society, to wit, feed, clothe, warm and transport human beings? The engineer may not himself grow the materials for food and clothing, but he does provide the mechanical means for converting many of them into food and clothes; and for transporting them from source to consumer. He also provides the means for warming and transporting human beings. In short, the engineer is very largely responsible for what Dr. Pritchett says is necessary for the continuation of organized society.

Not to eulogize but to point to another kind of service for the engineer, let us consider his relations to public utilities, meaning thereby steam and electric railroads; telegraph and telephones; electric lights and power plants; water and gas plants, and the like. These are as vital to our modern civilization as the circulating and nerve systems are to the body. The engineer having done his part in designing and building them is no longer concerned except as he may be called on to help operate or extend them in the future. That is to say, engineers are not doing their duty to the public in refraining from taking part in questions affecting the cost and value of utility properties and rates to be charged for service.

Public utilities are in the main owned by public-service companies. There is, however, a distinct trend toward public ownership. Behind may be changing social conditions, but in the foreground are dissatisfaction with the service and the rates charged. Out of misunderstandings have grown quarrels and fights which have for years occupied our courts and commissions. The question here is not the merits for either side but how to bring about mutual understanding. What are the factors which should govern in determining proper rates for service? and where is the line to be drawn in questions of public ownership? Although largely engineering in character, these questions apparently have not interested engineers very much. Why?

No one will question that the engineer, having been instrumental and largely responsible in building utility properties, is, or should be, well qualified to say what items go into their building and the cost of the items. In the absence of engineers, except a few, this important field of investigation has been occupied by others, who honest though they be, are ignorant of many important things. Thus courts and commissions have been reaching conclusions and rendering opinions which are not in every case based on all the facts.

The public is not to be blamed for its attitude, when those really qualified to have an opinion are silent. Public-service corporations have been charged too many times with high-handedness in the past. But they are for the most part the sins of the fathers; for whatever the public may think about it, the responsible officers of public-service companies are not today engaged in robbery;—they are fighting for existence. Hundreds of companies have gone into receivers' hands and the end is not yet. But that is not the worst of it. The public in working out its indignation may deal itself a blow as well as the company. It should remember that Sampson in pulling the house down to avenge himself on the Philistines also killed himself.

It is common knowledge that because of the quarrels between the public-service companies and the public no more money can be had for investment in utilities at low interest rates. Such investments are now regarded as too much of a gamble. It is safe to say that had it been foreseen that the charge allowed for service would be insufficient to meet necessities capital would not have been forthcoming and the utility would not have been created. And it is also safe to say that could it now be done without too serious loss capital would be withdrawn from public utilities. Public ownership would no longer be an issue but would become a necessity.

One of the contentions has to do with the amount of capital invested in the utility. The books show one amount, the appraisal another; and the public not knowing which is right accepts neither. Considering the imperfect methods of keeping accounts in the early days, difference of opinion among engineers and accountants as to the propriety of including certain items of cost is scarcely to be wondered at. The subject of appraisal and valuation is largely the development of the past twenty years, and comparatively few have engaged in this field of research. If engineers, accountants, commissions and courts cannot agree, how reasonably expect the public to be satisfied?

Why this lethargy of engineers in a matter of such vital importance? It certainly cannot be indifference. More likely it is due to the engineer being an idealist—an idealist in the sense that he is wrapt up in his constructive work, his interest in its problems being so great as to exclude other matters. Whatever the cause it is time the engineer roused himself and took more active part in public affairs. The public wants the opinion, not of individual engineers, but of the profession. More than that, the public wants the help that engineers can, because of their professional knowledge, render as citizens.

M. E. COOLEY.

Getting Together

THE essential unity of science is being more clearly recognized each day. Chemistry and physics merge in the study of the radioactive elements, the advances in colloid chemistry, the reactions promoted and the syntheses effected under the action of light, and in the important and expanding applications of electricity to process industry in many fields. All the experimental sciences are coming to lean more and more heavily upon the mathematician and to draw more generally upon each other to adjust or support their findings. Chemotherapy, the X-ray, radium, and synthetic drugs have placed new powers in the hands of the physician. Biology has now to reckon with vitamines, adrenalin, and the extraordinary influence upon the living organism of the chemical products of the thyroid and other glands.

With this general trend so clearly defined it is not surprising that the chemist and the mechanical engineer are finding new points of contact and developing a new sense of mutual dependence in their industrial activities. Bessemer supplies the engineer with cheap steel. Thomas and Gilchrist make available great bodies of phosphatic iron ores. As the requirements of the engineer become increasingly exacting the chemist provides tungsten, vanadium, and nickel steels. These the engineer turns to new account and by the development of high-speed tools revolutionizes the art of metal cutting. The engineer demands lightness with strength, and chemistry supplies aluminum. From its storehouse come new abrasives, better adhesives, more effective lubricants.

The burning of coal is a chemical operation, and to be carried out at high efficiency the process must be under chemical control. The whole fuel situation today is charged with impending change. It is plastic, but it cannot be shaped by the mechanical engineer alone. The problems involved in powdered coal, colloidal fuel, the Trent process, low-temperature distillation, gas enrichment, and motor fuel, to mention only a few of the factors in the complicated situation, demand for their solution the close coöperation of the chemist and the engineer. Similar coöperation is required if we are to secure the best results in the layout of piping and equipment, the selection of materials of construction, and the adaptation of structures to the needs of industry.

Chemistry is an experimental science, and chemists are trained to devise and conduct the experiments designed to secure answers to many of the questions of the mechanical engineer. The mechanical engineer deals with matter in the mass, and chemistry is concerned directly with the properties of the matter with which he deals. Here is the meeting ground on which the chemist and the mechanical engineer may coöperate to mutual advantage.

A. D. Little.

Dinner to American Deputation of Engineers

Two hundred of the elected officers of American engineering societies assembled in New York on October 10 to "welcome home" the deputations of American engineers which visited England and France this summer to convey greetings to the engineers of those countries. The names of those who went abroad and an account of the trip were published in the August issue of Mechanical Engineering, page 558.

The form of welcome was a dinner at the Pennsylvania Hotel at which Mr. J. Vipond Davies, president of the United Engineering Societies, acted as toastmaster. Distinguished guests included M. Gaston Liebert, French Consul General; Captain G. H. Armstrong, British Consul General; G. G. Clapperton, representing the British Institution of Electrical Engineers; Prof. Jacques Cavalier, spokesman for the French universities; and Governor James Hartness of Vermont.

Following speeches by Mr. Swasey, chairman of the delegation, and by Captain Armstrong, Mr. Charles F. Rand and Dr. Jewett described the functions which took place in England and Mr. John R. Freeman and Major Dwight those in France.

M. Liebert, on behalf of the French Government, presented medals commemorative of the mission's visit to that country to the presidents of the four national engineering societies, to the general chairman of the mission, and to the chairmen of the several society delegations.

Death of Dr. J. W. Richards

Dr. J. W. Richards, professor of metallurgy at Lehigh University and one of the foremost engineers of the country, died suddenly of heart trouble on October 12. Dr. Richards was born July 28, 1864 at Oldbury, England. He was educated in the Central High School, Philadelphia, the University of Heidelberg, the Mining Academy at Freiberg, Germany, and Lehigh University. He taught at the latter institution for over thirty years.

Dr. Richards was an authority on aluminum, a legal expert in chemical and metallurgical cases, had an international reputation in various branches of metallurgical technology, and was the author of many books on metallurgical and other engineering subjects.

He was a member of the United States Assay Commission in 1897; representative of The Franklin Institute to the International Geological Congress held in Russia in 1897; member of the jury of awards, department of chemistry, of the National Export Exhibition at Philadelphia in 1899; member of the jury of awards and chairman of the metallurgical subjury, Panama-Pacific International exposition, 1915; member of the United States Navy Consulting Board, 1915–1918.

He was a charter member of the American Electrochemical Society, its first president in 1902 and 1903 and its secretary since 1907. He was a member of The Franklin Institute of Philadelphia, president of the chemical section, 1897–1899, and professor of electrochemistry of the institute, 1907–1910.

Dr. Richards was a member of the Faraday Society, Deutsche Bunsen Gesellschaft, American Chemical Society, American Institute of Mining and Metallurgical Engineers, former vice-president of the institute and chairman of the iron and steel committee since 1914, member of the Iron and Steel Institute of Great Britain, of the American Iron and Steel Institute, of Société de la Chimie (France), of the American Institute of Chemical Engineers, and honorary member of the American Electroplaters' Association. He was a member of the Board of Engineering Foundation and a member of the National Research Council. He was representative of the American Institute of Mining and Metallurgical Engineers on the joint conference committee of the F.A.E.S.

Announcements of the DeLamater Ericsson Tablet Committee

The DeLamater Ericsson Tablet Committee announces that it has had a communication from the Board of Directors of the Association of Swedish Engineers (Svenska Teknologforeningen), Stockholm, Sweden, stating that they will hold a celebration of the sixtieth anniversary of the Battle of the *Monitor* and *Merrimac* simultaneously with the celebration which the Committee will hold in New York and Washington on March 9, 1922, as announced in the September issue of Mechanical Engineering. It is expected that members of the Royal Family and the American minister to Sweden will be present at the Swedish memorial meeting.

The Committee hopes by means of these contemporaneous celebrations to still further enhance the already very cordial relations between Sweden and this country, and hopes that American engineers and other patriotic citizens will coöperate with the Committee to this end.

DeLamater Ericsson Tablets on Exhibition

America's Making, Inc., under the auspices of the New York State and City's Departments of Education, will exhibit three centuries of immigrant contributions to our national life at the 71st Regiment Armory, New York City, October 29 to November 12. At the request of the Swedish Section, the DeLamater Ericsson Tablet Committee has been asked to make arrangements for having the DeLamater Ericsson Tablet models, the medals and diplomas presented to Captain Ericsson by this and other countries, and the Ericsson models of solar engines and other mechanisms now in the possession of The American Society of Mechanical Engineers, to form a part of this exhibit. The DeLamater Ericsson Tablet Committee, whose address is Engineering Societies Building, 29 West 39th St., New York, N. Y., consists of H. F. J. Porter, *Chairman*, Oakley R. DeLamater, Fred. A. Halsey, Axel S. Hedman, Ernst Ohnell, Henry R. Towne, and Chas. Vezin.

A.S.M.E. Annual Meeting in New York, December 5 to 9, Will Stress Importance of Industrial Waste Elimination

Professional Divisions to Discuss Avoidable Wastes—Strong Sessions on Education—Students to Conduct Session—Social Events to be Emphasized—Registration Fee

THE recent report of the Committee on Elimination of Waste appointed by the American Engineering Council emphasized the great responsibilities to be borne by engineers in elimination of industrial wastes in this country. Following out the recommendations in the report that each technical society give this matter intensive treatment, the program of the 1921 Annual Meeting of the A.S.M.E. will stress the engineering phases of the problem. The leading session will point out the necessity for waste elimination and develop the principles of standardization and stabilization which are essential in the movement. The professional sessions will contribute to the strength of the program by emphasizing, in a concrete technical way, the steps that can readily be taken to more effectively utilize our national resources. The names of the speakers for the leading session cannot be announced at the present time, but the Management Division, which is arranging the program, promises that the general question of waste elimination will be discussed in a broad, constructive manner. An inspiring session is assured.

Professional Sessions

The tentative program on page 755 shows an intimate relation between the leading session and the technical sessions whose programs have been arranged by the various Professional Divisions. The complete programs for some of these sessions are given. The Aeronautic, Ordnance and Forest Products Divisions have not entirely completed their lists of speakers. The Aeronautic Division contemplates a discussion of the economic possibilities of commercial aviation and two technical papers on the materials used in airplane construction; one of these, on cables, will be given by R. R. Moore. The Ordnance Division will present a paper by Colonel J. W. Joyes, Chief of the Technical Staff of the Ordnance Department, in which avoidable wastes in ordnance manufacture will be pointed out. The Forest Products Division will demonstrate how several lumber manufacturers have successfully reduced waste in the various processes involved in the conversion of the log into forest products. The experience of the Southern and West Coast districts will be related and the need for still further reduction in wastes will be emphasized.

The limitations of the Engineering Societies Building make it exceedingly difficult to hold more than three simultaneous sessions. Accordingly, the Council has this year granted permission to extend the meeting for five days, and the leading session will be called to order at 2.00 p. m. on Monday afternoon, December 5. As a further step to properly utilize every available moment, morning sessions will begin promptly at 9.30. It is believed that this will reduce the necessity for adjourned sessions.

Education

The importance of industrial education will be developed thoroughly at this meeting. Two sessions are to be held, one under the auspices of the Committee on Education and Training in the Industries, which will present a program pointing out the great needs for education in the industries. Dean R. L. Sackett of Pennsylvania State College will present in one of the papers a résumé of the status of industrial education throughout the country. The second paper, by D. C. Buell, of the Railway Education Bureau, Omaha, Neb., will relate the steps taken by the railroads of the country for the training of their men. It is earnestly hoped that this program will bring out discussion that will enable the committee to plan a constructive program for future industrial training.

The second session on education will be a joint meeting with the Society for the Promotion of Engineering Education. Prof. Dugald C. Jackson is in charge of the program, which will give an opportunity for mechanical engineers to discuss with teachers the requirements of an adequate technical-school training in mechanical engineering.

Students' Session

A new and important development in Annual Meeting projects will be launched at the coming December convention. The Committee on Relations with Colleges has charge of a session at which the papers will be prepared and presented by students. Discussion will be limited to students and the meeting will be conducted by students.

Honorary Members

The honorary memberships which have been granted to Henry R. Towne and Nathaniel G. Herreshof will be formally bestowed on Tuesday evening, following the address of President Carman.

Business Meeting

The business meeting has been scheduled for Wednesday, December 7. The entire day will be given over to the discussion of the policies of the Society and especially of the new constitution which appeared in Sectoin II of the August issue of MECHANICAL ENGINEERING. The business meeting is the especial opportunity afforded for the membership to discuss Society matters. The program has been arranged without conflicting sessions so that there will not be the excuse that opportunity is not granted to each member to stand on his feet and comment upon what the Society is or is not doing. The strength of the A.S.M.E. has been built on the activity and interest of its members, and its future growth depends on increasing this activity and interest.

Social Events

A program of social events somewhat more elaborate than that of last year has been planned for this meeting. In addition to the presidential reception, which will be held Tuesday evening, there will be a ladies' tea and dance on Wednesday afternoon, an informal get-together dinner for the membership on Wednesday evening, and a dinner dance on Thursday evening. Friday evening will be devoted to college reunions and the following institutions are planning events: Cornell University, University of Illinois, Lehigh University, Massachusetts Institute of Technology, University of Michigan, New York University, Pennsylvania State College, Polytechnic Institute of Brooklyn, Purdue University, Rensselaer Polytechnic Institute, Stevens Institute of Technology, Worcester Polytechnic Institute, and Yale University. The ladies' tea will be served Wednesday, December 7, at 3.30 on the fifth floor of the Engineering Societies Building. The place for the informal get-together dinner on Wednesday evening has not yet been chosen. An informal program will be given during the smoker which will follow the dinner. The dinner dance will be held at the Hotel Astor. In view of the great popularity of this function in previous years it is probable that reservations will be required well in advance of the meeting. The circular, which will go out to the membership early in November, will give complete information regarding such reservations. On Thursday a luncheon is planned for members of Sigma Xi honorary scientific society.

Excursions will lead to points of technical interest about New York. The Friday afternoon excursion will be one of interest to the entire membership.

The ladies will be made especially welcome at this meeting. A reception committee will be in constant attendance and opportunities will be given to visit interesting points of the city.

Special Railroad Rates

Arrangements are being made to provide special railroad rates for members attending the meeting. Complete information regarding this will be in the Annual Meeting circular. It is requested that every member who is coming to the Annual Meeting make

TENTATIVE ANNUAL MEETING PROGRAM

New York, December 5-9, 1921

(Other subjects or changes to be announced later)

Monday Morning, December 5
Local Sections Conference
Council Meeting

Monday Afternoon, December 5
Leading Session: Elimination of Waste in Industry

Monday Evening, December 5
Session on Education and Training in the Industries

Tuesday Morning, December 6 (Simultaneous Sessions)

POWER WASTE SESSION

Heat Balance of:
Connors Creek Station of the Detroit Edison Co., C. H. Berry
Colfax Station of the Duquesne Light Co., C. W. E. Clarke
Delaware Station of the Philadelphia Electric Co., E. L. Hopping
Hell Gate Station of the United Electric Light & Power Co., J. H. Lawrence and W. M. Keenan

MACHINE SHOP WASTE SESSION

Waste in Machine Industry (two papers), J. A. Smith and J. J. Callahan
Art of Milling, John Airey

RAILROAD WASTE SESSION

Avoidable Waste in Operation of Locomotives and Cars, Wm. Elmer
Avoidable Waste in Locomotives, Jas. Partington
Avoiding Waste in Car Operation, W. C. Sanders

Tuesday Afternoon, December 6 (Simultaneous Sessions)

MANAGEMENT WASTE SESSION

Making Work Fascinating, W. N. Polakov
The Process Chart, F. B. and L. M. Gilbreth

FOREST PRODUCTS WASTE SESSION
(Authors to be announced)

Excursions

GENERAL SESSION

Testing of Emergency Fleet Boilers Using Oil Fuel, F. W. Dean
Stresses and Deformation in Flat Circular Cylinder Heads, A Mathematical Analysis, Maj. G. D. Fish
Control of Centrifugal Castings by Calculation, R. F. Wood

Tuesday Evening, December 6
Presidential Address and Reception
Conferring of Honorary Membership

Wednesday Morning, December 7
Business Meeting

Wednesday Afternoon, December 7
Business Meeting
Ladies' Tea and Dance

Wednesday Evening, December 7
Dinner and Informal Get-together

Thursday Morning, December 8 (Simultaneous Sessions)

FUEL WASTE SESSION

Boiler Plant Efficiency, Victor J. Azbe
Fuel Saving in Relation to Capital Necessary, Jos. Harrington
Developments in Boiler and Furnace Design, D. S. Jacobus
Producer Gas for Industrial Furnaces, W. B. Chapman

MATERIALS HANDLING WASTE SESSION

Industrial Waste in Handling of Material, H. V Coes

STUDENT SESSION
(See page 754)

Thursday Afternoon, December 8
Joint Session with Society for Promotion of Engineering Education
Excursions

Thursday Evening, December 8
Dinner Dance

Friday Morning, December 9 (Simultaneous Sessions)

TEXTILE WASTE SESSION

Report on Second World Cotton Conference, Chas. T. Main
Hidden Wastes in Textile Mills, T. P. Gates
Research Results in Cotton Spinning, A. N. Sheldon
Economy in Textile Drying, B. R. Andrews

ORDNANCE WASTE SESSION
(Authors to be announced)

AERONAUTIC WASTE SESSION
(Authors to be announced)

GAS POWER WASTE SESSION

Porting and Charging of Two-Stroke Oil Engines, Louis Illmer
Paper by E. A. Sperry (title to be announced)

Friday Afternoon, December 9
Council Meeting
Excursions

himself familiar with the provisions regarding these rates so that the entire membership may receive the benefit therefrom. The awarding of the one-half fare rate on the return trip depends upon the number of members who apply for certificates before leaving their homes. These certificates are turned in at the Annual Meeting headquarters and if a sufficient number are received the one-half fare rate is awarded. It is important, therefore, that every member attending the Annual Meeting make request for the certificate.

Registration Fee

The Committee on Meetings and Program, with the approval of the Council, has authorized the levying of a registration fee of \$1.00 for each member and \$2.00 for each male guest. Ladies are to be registered without charge. This registration fee has been imposed only after very careful consideration of the various principles involved and knowing that the membership thoroughly believes that the meetings of the Society should be at least partially self-supporting.

Snow Removal From City Streets a Problem For Engineers

A.S.M.E. Materials Handling Division Discusses Fundamentals of the Problem and Various Methods of Melting, Compressing and Conveying Snow

THE removal of snow from city streets is a problem requiring adequate machines, thorough organization and forceful administration. An engineering discussion of this problem took place on Friday evening, September 23, at a meeting of the Materials Handling Division of The American Society of Mechanical Engineers held in the Engineering Societies Building under the auspices of the Metropolitan Section.

Walter S. Finlay, Jr., chairman of the Metropolitan Section, opened the meeting and after a short business session relinquished the chair to Nathan C. Johnson, member of the Executive Committee of the Materials Handling Division.

The first speaker was Henry L. Doherty, whose interest in the problem had been aroused by his observation of removal methods used at the time of the heavy snowfall in New York on February 20, 1921. Mr. Doherty's views are expressed in an editorial in the August issue of MECHANICAL ENGINEERING and in his correspondence with various officers of The American Society of Mechanical Engineers, printed copies of which are available on application at Society headquarters. In his address, Mr. Doherty pointed out the immensity of the problem of removal of a snowfall in a large city of even a few inches. In New York City a snowfall of 12 inches means a total weight of approximately 3,000,000 tons of snow on the 3500 miles of streets. Upon the assumption that snow must be handled so as to impede traffic in the least possible degree and for the shortest possible time, Mr. Doherty suggested, as first aid only, that footpaths should be made at the curb, throwing the snow toward the building line, that one-way streets be decided on, and that on two-way streets road paths should be cleared on the sides, piling the snow in the center, and sidewalks cleared at the curb. All of this should be done after a careful survey is made of every foot of New York streets and maps prepared showing where snow may be piled. To avoid hauling, which seems exceedingly expensive, Mr. Doherty suggests the making of snow briquets. He calls attention to the fact that ice is ten times as dense as snow and that with a briquetting mechanism a 12-inch snowfall on a 60-foot street may be piled in a wall three feet wide and three feet high where it will not interfere with traffic and will melt without inconvenience to vehicles or foot passengers. Mr. Doherty also discussed other methods of removal and advocated the use of the method which proved most economical for each particular locality.

John P. Leo, commissioner of street cleaning of New York City, emphasized the importance of snow removal to maintain the health and safety of the city. He described the experience in New York during the winter of 1919–20 when the traffic in the business section of the city was practically tied up, resulting in the development of a commission under the chairmanship of Fire Chief John Kenlon to suggest a solution of the problem which was tried out during the winter of 1920–21. The city was mapped out in districts, to each of which tractor plows and motor trucks were assigned and located in the fire-engine houses in these districts. Routes were laid out and the plows patrolled these routes from fixed points. Trucks were loaded from the piled snow and dumped into the nearest sewer. The cost of removal of a million and a half cubic yards was one million, eight hundred thousand dollars in 1920–21. From this experience it is now planned to clear and load the snow as it falls, using plows, conveyor loaders and trucks to get the snow into the nearest sewers. This can be done best as the snow is falling, when there is generally very little freezing. The Department of Street Cleaning is at work on a mechanical loading apparatus which will pick up the snow and deposit it in the trucks to be carted away. A number of slides were shown of the apparatus used in 1919–20 and 1920–21 for the handling of snow in New York City.

The Fundamentals of the Problem

John T. Fetherston, former commissioner of street cleaning of New York City, analyzed the snow problem into the following three elements:

1 For what depth of fall, density, rate, duration and occurrence of snow shall the city reasonably prepare each winter?

2 What are the allowable maximums for the design of the organization and apparatus?

3 The next pertinent or possibly impertinent question to ask is, how many hours or days should reasonably be allowed for the removal of the snow from the scheduled area, meantime keeping the streets free for the movement of traffic, in order that the citizens of the town may judge reasonably of the efficiency of the organization, methods, procedure, management and apparatus of the municipality?

As to the solution of the problem he made the following statement:

If the mechanical engineers would voice the sentiments of the public by setting up physical standards for snow work in New York and other cities, the people would then be in a position to judge of the real efficiency of their chosen officials, on a basis of fact.

Moreover, the officials would undoubtedly welcome a reasonable standard by which the results of their work could be judged. No such standard exists and it is unfair and unjust to condemn officials for the times they fail to vanquish a fifteen-inch snowfall followed by zero weather with six-inch equipment and underfed, poorly clothed, inadequately shod humans.

The Solution of the Snow Problem:

1 Set up the standards of quantity, quality, time and conditions as a basis for the design of organization, methods, procedure and equipment.

2 Provide the personnel and the apparatus to meet the conditions. Make the work attractive to available forces by offering pay commensurate with the work and the results secured.

3 City officials come and go. There have been eleven commissioners of street cleaning in twenty-three years since Greater New York was organized—an average official life of about two years to learn the city charter and the details of an organization comprising 7,000 men, serving 6,000,000 people scattered over an area of 140 square miles of territory.

The solution of the snow problem and other municipal problems will come nearer realization when engineers mark the targets for the officials to shoot at and exercise their duties as prospective leaders of public opinion by presenting, say to the New York Charter Revision Commission, the underlying principles of successful administration applicable to public office in such form as may readily be translated into law. Methods, apparatus and devices alone will never solve the snow problem, but organization, capable administration and effective execution with the right man behind the gun will score many bull's-eyes.

At the close of Mr. Fetherston's talk, John Kenlon, chief of the New York Fire Department, gave a dramatic account of the struggle with the snow during the winter of 1919–20. As the result of this struggle, which was led by the Fire Department, Chief Kenlon was made head of the Commission which formulated plans for handling the snow during the winter of 1920–21.

To emphasize the great fire risk developed by blocking the streets to the movement of fire apparatus, G. W. Booth, of the National Board of Fire Underwriters, gave an estimate of building valuations in New York City. In the area from the Battery north to Fortieth Street the total valuation for buildings and contents was given at two billion, two hundred and twenty-three million, four hundred thousand dollars. In the area between Fourth and Seventh Avenues from Fourteenth to Fortieth Streets there is a total of six hundred and thirty-six million dollars involved. Although there is an almost continuous line of sprinklered fireproof buildings through the center of the city, there are many old and poorly constructed buildings on both sides. It is in these buildings that fire might start which under adverse circumstances, such as snow-blocked streets, would spread to adjoining buildings and blocks and become a conflagration. In conclusion Mr. Booth pointed out that the Fire Underwriters are constantly keeping in mind that sometime impossibilities often become actualities. The prompt response of the fire department is an extremely important factor, and snow removal may be the controlling element in such response during a severe storm.

Devices for Snow Removal

The remainder of the program was devoted to the consideration of details of methods for snow removal. The chairman read a letter from Thomas A. Edison in which he pointed out that some

forty years ago a machine was built to gather all the snow in front of it, pass it into a compressor and deliver blocks of ice into the gutter behind.

George L. Sawyer, western manager of the Barber-Greene Company, Aurora, Ill., emphasized the importance of a solution of the snow-handling problem to every city throughout the country. He grouped the processes involved in the removal of snow in two major operations. The first is that of meeting requirements of commerce and convenience by opening a lane for traffic, and the second is that of meeting the requirement of public health to the extent of entirely removing the snow.

Mr. Sawyer recited some of the efforts being made throughout the country to solve the snow problem as follows: Adaption of the kerosene pressure torch, the introduction of steam into water hose to melt snow, flame throwers, and snow melters of the furnace type of similar to those used for reheating asphalt. These methods require artificial channels such as gutters, etc., for the disposal of the melted snow. The heating units must be portable and are not practical unless the fuel is cheap. In the field of purely mechanical devices Mr. Sawyer mentioned the plow, snow compressor, rotary plow, the crane and clamshell bucket, and the combination of the belt conveyor and scoop. For the transportation of the snow itself he suggested the common vehicles, used in combination with river, stream, gutter or sewer. Mr. Sawyer pointed out that in three of the largest American cities in the past winter successful demonstrations of snow removal have been made. The first procedure was to open up the principal thoroughfares for traffic as quickly as possible, lanes being cleared of snow by means of sweepers or plows and the snow being deposited in piles in the center of the street. The snow deposited was loaded mechanically into trucks and taken to streams or sewers. The snow loader used in these three cities consisted of a 32-in. belt conveyor, installed at an angle of approximately 25 deg. on a continuous-tread tractor. At the lower end the 32-in. section was increased to a scoop-shaped section having a width of 6 ft. Motive power was obtained from the 25-hp. gasoline engine which moved the entire machine as well as the conveyor. A truck could be located immediately behind the snow loader so that only the width of the machine was needed for snow removal. This machine described by Mr. Sawyer permitted trucks to be moved out at intervals of from two to six minutes. He estimated that savings over manual removal, based on reduced labor cost and increased truck "turnovers," were as high as $550 per snow loader per eight-hour shift. Mr. Sawyer recommended the use of mechanical methods during the night because of decreased traffic at that time. At the close of his talk Mr. Sawyer suggested that the A.S.M.E. would render an important service if it collected and sifted information on this subject.

Mr. D. L. Ellis, assistant engineer of the Great Northern Railroad, Seattle, Wash., presented a scheme for using a gas-electric rotary snow plow for taking up the snow, shooting it to the side of the street or dropping it in trucks alongside of the plow. Mr. Ellis' device is shown in Fig. 1.

Chairman Johnson read abstracts of contributions from Mark A. Guigou, New York, N. Y., W. Lehman, Milwaukee, Wis., and E. C. Donner, Pittsburgh, Pa.

Mr. Guigou's device, shown in Fig. 2, is an indication of a design believed to be practicable by the author, with which it is proposed to compress snow to from one-quarter to one-eighth its initial volume without the use of an excessive amount of power. The figure indicates a double-walled or jacketed tubing machine cylinder with the gasoline engine exhausting through this jacket, thus utilizing the exhaust heat to melt the snow adjacent to the walls of the machine cylinder and facilitating its passage through the cylinder bore. The compressed snow would emerge from the tubing machine in a hard column which could be delivered directly to the truck immediately in the rear of the tractor. In this way each truck could be loaded to its full-weight capacity.

Mr. Lehman's contribution suggested, first, the mapping of the city to show where snow could be piled with least inconvenience; second, a shovel of 3 cu. yd. capacity, like a steam shovel but compressing the snow in the shovel by the forward movement of the truck, so that with a fall of 1 ft. or less a truck travel of 20 to 40 ft. would be necessary to fill the dipper. The shovel would then be lifted and dumped into a truck. Mr. Lehman estimates that this device could be operated at a speed of two miles per hour, that the machine would weigh about four tons and cost from three to four thousand dollars.

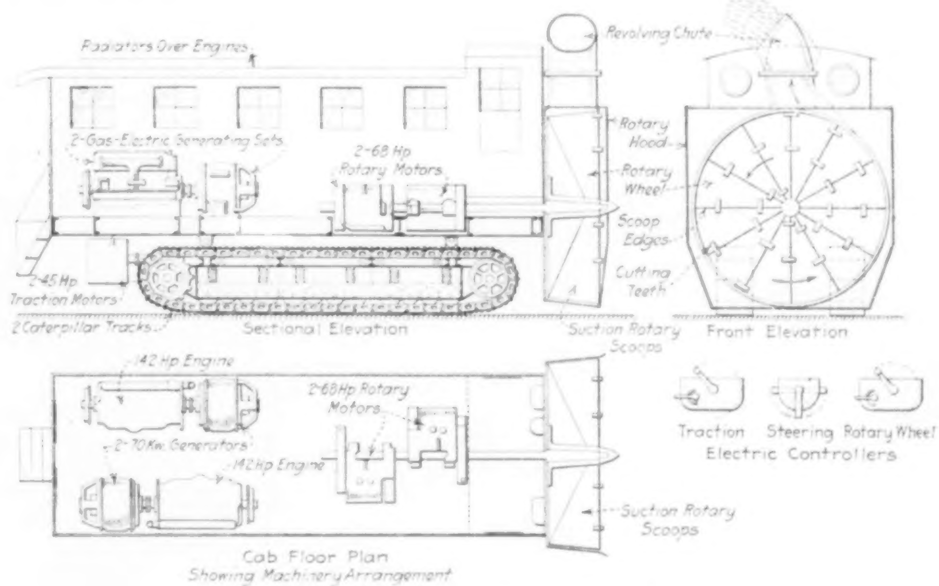


Fig. 1 Ellis Gas-Electric Rotary Snow Plow

E. C. Donner suggested a scraper of street width drawn by a tractor or trolley car and followed by two machines consisting of scoops and screw-type compressors for briquetting the snow in cylinders. These briquetting machines will be followed by trolley or gasoline trucks to collect the ice cylinders.

John Flodin, of Quincy, Mass., presented lantern slides showing a modification of loaders successfully used for handling gravel, coal, etc. The conveyor, which should be mounted on the necessary truck or tractor, has at its front end a blade or scoop attached to start the snow on the belt. Provision is made for the conveyor chute to be lowered while passing under elevated structures, trolley wires, etc. Mr. Flodin also presented a sketch of a simple power-driven snow-shoveling device. To take care of the possibility of snow remaining on the street until it forms ice, Mr. Flodin suggested an ice breaker consisting of a rotary multi-tooth clipper or breaker, a tilting and dumping scoop and a melting hopper into which the scoop is discharged. All these parts are mounted on a truck or tractor to be steam-driven, Exhaust steam and waste gas is used to melt the ice.

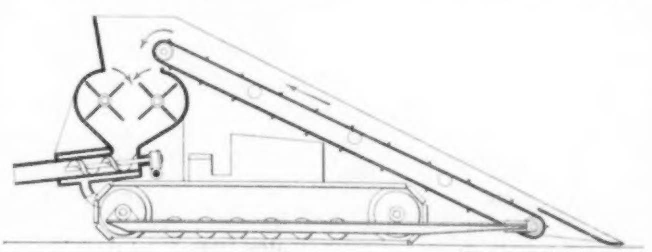


Fig. 2 Guigou's Machine for Compressing Snow to a Quarter of Its Original Bulk

Experiences in Snow Melting

A. Parker-Smith related some experiences in snow melting. On the basis of 14,000 B.t.u. per lb. of soft coal or gas-house coke, and using the latent heat of fusion of 1 lb. of snow or ice or 140 B.t.u., Mr. Parker-Smith estimated that one ton of coke at $10.50 per ton delivered should melt 100 tons of snow. Estimating a 75 per cent heating efficiency, the fuel cost of a well-packed two-horse-truck load of snow would be twenty-one cents. On the same basis Mr. Parker-Smith estimated the fuel cost of melting the snowfall on a Fifth Avenue block as $10.50.

He also told of snow melters built thirty years ago, some of which were tried out in New York City. One of these set up in Hancock Square was used to melt 86,000 lb. of snow in four hours, consuming 1000 lb. of coke. Difficulties of operation were found to be dirt in the water jacket and clinkers which clogged the draft. In conclusion Mr. Parker-Smith stated that snow can be melted more cheaply than it can be carted to the river from any but riverside sections.

In the discussion David Moffat Myers suggested melting by use of hot water in congested districts. Assuming 80 per cent efficiency and 16 per cent loss in mixing, with coal at $8 per ton, Mr. Myers estimated the cost for melting the snow would be two cents per cubic foot.

Chief Kenlon called attention to the fact that the weather in New York City may be severe, which makes the melting of snow exceedingly difficult. He emphasized the necessity for machines being compact and stated as his opinion that the problem would not be solved by the adoption of any one method but rather by the utilization of the best method for any particular locality. He believed that a sewer is the best, most practical conveyor for removing snow, although the sewers of New York south of 59th Street are generally inadequate.

Further Studies Contemplated

Upon motion by Mr. Doherty, the meeting passed a resolution that a committee be appointed by the Materials Handling Division to study the snow-removal problem and present its findings for the benefit of the cities of the country. This committee is to plan its own course and raise the money necessary for the execution of its plans.

In his closure Mr. Doherty pointed out that the removal of snow by melting is the most difficult method because it involves handling in addition to the melting process. Mr. Doherty stressed particularly the idea that there is great waste in handling snow unless it is compressed. Trucks or trailers cannot be loaded to weight capacity with snow as it falls. As an emergency measure Mr. Doherty recommended that snow should not be moved from private property into the street. He believed that it would be better to pile snow on the sidewalk and level it off as pedestrians can walk on twelve inches of snow as easily as on one inch. In the use of heat, direct contact is the most effective method. Salt and calcium chloride have proven ineffective and impractical. Snow removal seems to be a mechanical problem and from this point of view briquetting is advisable in order to get greatest effectiveness from conveying vehicles. Mr. Doherty further pointed out the advantages that sunlight has in snow removal especially when dust or other black material covers the snow thereby reducing the reflecting effect of the sun and absorbing the heat of the sun.

Devices not Presented at the Meeting

A number of devices were described by members who could not be present, some of which are worth attention. Edward A. Smith of West Englewood, N. J., suggested the application of heat to snow after the snow is separated into flakes. The device he has evolved includes a revolving wheel which will scatter into a melting chamber of 67,440 cu. ft. capacity a continuous stream of snow 42 in. wide, 12 in. high and 3.9 in. thick. The snow is kept agitated by compressed air and oil is used as fuel. Mr. Smith estimates that 76,500 cu. yd. can be melted in 28 hours. At this rate one hundred machines would be required for Greater New York costing per day twenty thousand dollars for oil, seven thousand dollars for men and one thousand dollars for electric current. Based on the total winter's snowfall of 7,400,000 yd., the season's cost would be $2,220,000, or thirty cents per cubic yard.

Messrs. Thomas Chester and Bernard Kern of Sandusky, Ohio, came to the conclusion that the only successful method of removing snow is one that can be put into operation as soon as one or one and one-half inches of snow have fallen, machines to be kept operating over the same territory during the snow storm. They suggest a sweeper and scraper which can be adjusted to drive the snow to one side where it can be loaded into trucks by hand.

Francis B. Sando, of Newark, N. J., recommended the use of a rotary brush mounted on a gasoline truck which has been used in New Jersey to open the highways.

H. S. Farquhar of Wayne, Pa. has sent in a clipping from *Engineering News* of July 27, 1905, in which his patent granted in 1901 is described. Mr. Farquhar proposed a snow-compressing machine which utilizes a screw. The article relates various attempts at compression in which Mr. Farquhar tried compression between rolls, compression between one roll and stationary plate, compression by forcing between converging surfaces and compression with a piston. The important feature of Mr. Farquhar's device was the idler which was found necessary to keep the compressor screw clean of snow, thereby preventing choking. A report made by Mr. William B. Upton upon Mr. Farquhar's device stated the capacity of the machine to be 4 cu. ft. of snow per min. The compressed block from this machine weighed 55 lb. per cu. ft. which is within $2^3/_4$ per cent of the weight of solid ice. The power consumed was about 0.33 hp.

STEAM-CONDENSING PLANTS

(Continued from page 716)

else at greatly increased velocities and correspondingly increased rates of condensation. The main supply of water passes directly through the upper and larger group of tubes and the remainder of the water after passing through the cooler, goes through the lower and smaller group of tubes below the deck or partition.

The rate of condensation in a condenser with all its tubes active was found to vary substantially as the rate of condensation on a single tube, which, as is well known, depends on its diameter and material and the water velocity. With only one passage necessary, an entirely new basis for selection of velocity and tube size is opened to the designer. High velocity or small tubes or both can be used without excessive pump power as would be encountered with multiple-pass construction. Paradoxically, there is more insurance against corrosion, as well as greater protection against reduction of vacuum by scaling and sliming, when working the condenser at the higher and apparently less conservative condensation rates. The author does not wish to imply that excessive pump powers should be used. High capacities and velocities may be obtained without exceeding circulating-pump powers now often used. The circulating-pump capacity is best arranged in twin units so that maximum water quantity and velocity are available in summer and can be reduced in winter by shutting down one pump. Variable or graded circulating-pump capacity is desirable in small as well as large units.

On large units having two water pumps, one of which is shut down in winter, provision can be made for preserving high velocities even with reduced water quantity. At high vacuum with cold water, the top tubes in large condensers do most of the work and therefore the smaller winter quantity should be concentrated on these tubes, thus maintaining high velocities in the tubes which tend to foul and corrode.

In the summer time both pumps supply water to the two nozzles (Fig. 14) serving sections A and B, and a small quantity of water is supplied the coolers and from them to section C at the bottom of the condenser. In winter one pump is shut down, the valve to section B shut, and the plates in the deck between B and C removed thus throwing these two tube banks in parallel so that they both receive water from the coolers. The main water supply is then concentrated on the upper section A. This design also has the advantage that at any time the entire capacity of the two pumps may be concentrated on section A or B, thereby producing extremely high cleaning velocities, also, that either section A or B can be shut down independently and the water-box covers removed for inspection or cleaning.

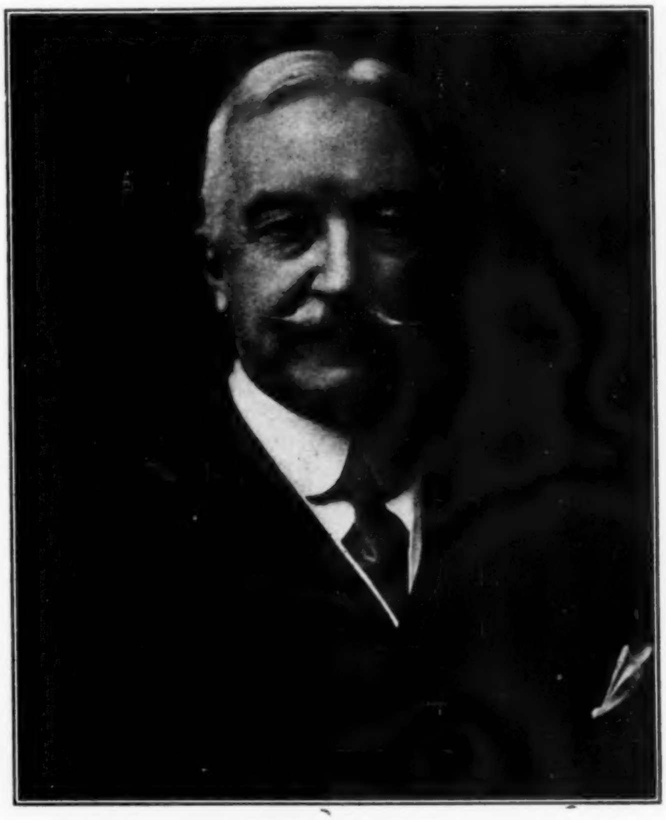
Dean Cooley New President of American Engineering Council

Election of Successor to Herbert Hoover Announced at September Meeting of Executive Board of Council—Important Committee Reports and Other Matters Brought Up for Consideration

IN THE recent election, announced at Washington September 30, of Mortimer E. Cooley, dean of the Colleges of Engineering and Architecture of the University of Michigan, as president of American Engineering Council, the executive body of The Federated American Engineering Societies, the organization secures as its leader a man widely and favorably known not only to the engineering profession but to the general public. Dean Cooley has been elected to fill the vacancy caused by the resignation of Herbert Hoover after he became Secretary of Commerce.

Mortimer Elwyn Cooley was born in Canandaigua, N. Y., March 28, 1855, and was graduated from the United States Naval Academy in 1878. Following cruises in the Mediterranean and to Newfoundland, he was ordered to the Bureau of Steam Engineering, where he remained until July, 1881, in the drafting and design department. He was then stationed at the University of Michigan for four years as professor of steam engineering and iron shipbuilding, at the end of which time, at the request of the regents, he resigned from the Navy and accepted the chair of mechanical engineering at the university. He became dean of the College of Engineering in 1904 and of the College of Architecture in 1913.

During the Spanish war Dean Cooley served as chief engineer of the *Yosemite* which acted as convoy and did blockade duty off Santiago, San Juan and the Jamaican coast. For a time following the war he was attached to the League Island Navy Yard, engaged in engineering work.



Mortimer E. Cooley

In 1899 he returned to the university and during the years following undertook a large amount of important appraisal work, the total value of the property with which he has been concerned in appraising being about a billion and a half dollars, of which 85 to 90 per cent has been for the public. From 1907 to 1912 he acted as chairman of the Block Signal and Train Control Board, Interstate Commerce Commission. At the Chicago Exposition he was a member of the Engineering Committee and at the Pan-American Exposition he served on the Committee of Awards.

Dean Cooley was vice-president of the American Association for the Advancement of Science in 1898, president of the Michigan Engineering Society in 1903, a director of the American Society of Civil Engineers from 1913 to 1916, vice-president of the Society for the Promotion of Engineering Education, 1908–1909, and its president, 1920–1921. He became a member of The American Society of Mechanical Engineers in 1884, and served as its vice-president during the year 1902–1903, as chairman of the executive committee, Detroit Section, 1916–1917, and as president of the Society during the year 1918–1919.

Concerning the election of Dean Cooley, L. W. Wallace, executive secretary of the American Engineering Council, said:

> It is indeed gratifying to have such a man as Dean Cooley as president of the American Engineering Council. Dean Cooley is a man of splendid accomplishment both professionally and personally, and is widely and favorably known to the public and to engineers. He is a man that has rendered splendid service to the engineering profession, and it is confidently expected that in his capacity as president of the Federation he will render a still greater service to the public and to the engineering profession by virtue of the larger opportunity.

Committee Reports

The September 30 meeting of the Executive Board of the American Engineering Council was the first to be held at Washington D. C., since its initial meeting, held there November 20, 1920. The presiding officers were Calvert W. Townley and J. Parke Channing of New York, vice-presidents. Approximately twelve hours were devoted to an intensive and earnest consideration of various matters of importance, including the reports of the Committee on Patents, the Committee on Employment, Committee on Government Contracts, and the Committees on Registration and on Classification and Compensation of Engineers.

The Council adopted the report of its Committee on Patents, which urged the passage of the Lampert Bill to remedy conditions in the Patent Office, and approved a resolution expressing the conviction that this bill "provides the least increases in force and salaries which can possibly stop the retrogression of the Patent Office and enable it to make progress toward recovering an efficient condition, and, by increases in the fees for patents, supplies the funds necessary to enable the Patent Office to continue to be self-supporting." The Council will also support the committee in its opposition to the passage of the Stanley Senate Bill which provides for an amendment to the Patent Act, requiring that all alien-owned American patents shall be worked in this country within two years after the granting of the patents.

After a long discussion of the report of the special Committee on Employment, a committee of the Board was appointed to draft resolutions which would crystallize the general thought brought out by the discussion. The committee reported the following resolutions which were adopted:

> Whereas, The need is pressing for a unified employment service for engineers, national in scope, local in application, and financed for adequate service; and
>
> Whereas, The contributions which the constituent societies of The Federated American Engineering Societies are able to make to the Employment Bureau have been found inadequate to provide an Employment Service such as engineers require; therefore, be it
>
> *Resolved:* That the Executive Board of the American Engineering Council endorses in principle a paid employment service but with reduced fees to members of organizations supporting said service; and be it further
>
> *Resolved:* That a Committee of five members of the Executive Board be appointed by the Chairman and that the Boards of Direction of the four founder societies be requested each to appoint a member of its board in order to form a Joint Committee of nine members on Engineering Employment with the power to organize an Employment Bureau, on a plan which will invite the coöperation of interested organizations.

The Committee on Government Contracts made a number of important recommendations. Some of the more significant recommendations approved are:

> 1 That Government work be normally carried out through unit-price or lump-sum contracts, or by the purchase and hire method. Where none of the above methods are applicable to conditions, that the cost-plus method

be used in which the contractor is refunded the actual cost of the work, plus an accorded compensation which increases if the work is done below the estimated cost of the work, and decreases if the work costs more than estimated, but never sinks below zero;

2 That there be appointed by the President an Inter-Departmental Board on Standardization of Contracts, consisting of one representative of each Government department engaged in construction. That this Board recommend policies to govern in the standardization of contracts within each department. Each department should have a small board representative of each bureau engaged in construction, and should seek to unify and standardize contract practices within the Department, and the chairmen of these Departmental Boards might preferably constitute the Inter-Departmental Board, which should be only advisory in character. That when the contracts of each department shall have been by itself thus standardized, that the Inter-Departmental Board consider these contracts and make necessary recommendations to harmonize and secure, so far as feasible, uniformity of practice in the different departments;

3 That all Government officials shall recognize the importance of exerting the utmost efforts to make prompt partial payments on Government contracts at reasonable intervals as stated in the contracts, for all services rendered and materials delivered by the contractor, on the work that has been accepted by the Government inspector;

4 That payment shall in all cases, as far as possible, be made by the official or agency directing the work, and not by an outside accounting or financial agency, in order to avoid the burden on the contractor of delays in payments when made by such an agency not directly concerned with, or responsible for the efficiency, economy and dispatch of the work.

The report of the Committee on the Registration of Engineers was considered and referred back to the Committee for revision. Following a recommendation of the Committee on the Classification and Compensation of Engineers, the Executive Board endorsed the classification of engineers as proposed by the Committee on Classification and Compensation of Engineering Council in its report of December 15, 1919, as in the judgment of the Board generally applicable to all branches of engineering. The Executive Board also authorized the chairman to appoint a sub-committee to make a comparative study of such proposed legislation on this subject for the purpose of presenting to the Council a final report and recommendation for action.

The Executive Secretary was authorized after advice with the Committee on Procedure to organize in such states as may seem to be necessary, State Administrative Committees, thus providing mediums whereby the Federation may obtain quick and direct action pertaining to any of its activities. Such committees would be organized after conference with member organizations. In those states that have an all-inclusive state organization that organization would be requested to recommend representatives on the State Administrative Committee, and in the case of a state where there is not an all-inclusive society, the national organization will be asked to make recommendations. In every instance an effort would be made to obtain representatives of the various branches of engineering and of member societies.

Miscellaneous Business

In view of the general business situation involving the probability of lessening the attendance, it was decided not to hold the engineering assembly planned for January, 1922. The committee in charge of the arrangements was converted into a program and entertainment committee for the Annual Meeting of the Council to be held in Washington in January.

Col. Arthur S. Dwight, official representative of the F.A.E.S. on the deputation of engineers to England and France in June, presented his report, in which he called attention to the active interest in the Federation manifested by British engineers, who have already taken steps to organize the engineers of the Great Britain along the lines pursued by the F.A.E.S.

The resignation of Mr. A. C. Oliphant as assistant secretary was announced. Mr. Oliphant was associated with the Engineering Council previous to the organization of the American Engineering Council and has rendered valuable service in both capacities. He is to become associated with M. O. Leighton and Company, consulting engineers, Washington, D. C.

The applications for membership of the Vermont Engineers' Society and the Associated Engineers of Spokane were approved.

A resolution was passed by the Board approving the decision of the National Board for Jurisdictional Awards in the Building Industry with respect to the award affecting the Brotherhood of Carpenters.

Progress was also reported by other committees. In general it was felt by the attending members of the Board that the work of the Federation was advancing in a satisfactory manner.

Engineering and Industrial Standardization

A Group of Standard Specifications Prepared by the American Society for Testing Materials and the Bureau of Mines Now Under Consideration by the American Engineering Standards Committee

THESE specifications are submitted in accordance with the special provision in the procedure of the American Engineering Standards Committee under which important standards in existence prior to 1920 may be approved without going through the regular process followed in new work. The Committee would be very glad to learn from those interested of the extent to which they make use of these specifications and to receive any other information regarding the specifications in meeting the needs of the industry. Copies may be obtained from the American Engineering Standards Committee, 29 West 39th Street, New York City. Price 25 cents each.

Specifications for Drain Tile

The history of the A.S.T.M. specification for Drain Tile dates back to 1911 when the A.S.T.M. organized its Committee C-6 on Drain Tile to meet two very urgent conditions. The comparatively recent use, on an extensive scale, of very large drain tile in public drainage works for reclaiming wet lands had brought about the unexpected discovery that these large drain tile were quite subject to cracking in the ditch under the weight of the ditch refilling. Also, the extensive production of concrete drain tile, and the resulting controversy between clay-tile and concrete-tile producers as to the merits of the new material made it urgent that additional data be secured.

The first task of the newly organized committee was to plan and conduct a series of investigations covering methods of tests, the determination of desired quality and durability of drain tile, and a study of methods of manufacture and of construction and field specifications. In this work it was actively assisted by the following engineering laboratories: Iowa Engineering Experiment Station, Ames, Iowa; Municipal Testing Laboratory, City of St. Louis, Mo.; University of Wisconsin, Madison, Wis.; Lewis Institute, Chicago, Ill., and the Engineering Laboratory of Edward Orton, Jr., Columbus, Ohio.

The manufacturers of clay and concrete tile coöperated by furnishing materials for tests. The American Society for Testing Materials estimates that these investigations, which extended over five years, from 1911 to 1915, cost at least $25,000.

In 1914 Committee C-6 prepared Standard Specifications for Drain Tile covering strength tests, quality and requirements for strength of tile as used in ditches. These specifications were tentatively adopted, subject to revision. The specifications were revised in 1916 and 1921, the latter revision consisting of a modification of the methods of making the freezing and thawing test as the result of investigations which had been under way for some time. The revised specifications are contained in the 1921 volume of A.S.T.M. Standards.

Methods of Analysis of Manganese Bronze and Gun Metal

Two standard methods of analysis entitled Methods of Chemical Analysis of Manganese Bronze (B27-19) and Methods of Chemical Analysis of Gun Metal (B28-19) have been prepared by Committee B-2 on Non-Ferrous Metals and Alloys of the A.S.T.M. They were based upon several methods in use when the preparation was first undertaken in 1917. After standing as tentative for one year, they were adopted without revision as standard by

the Society in 1919. These specifications may be found in the 1919 volume of A.S.T.M. Standards.

Steel Forgings

Among the eleven standards of the American Society for Testing Materials now before the American Engineering Standards Committee for consideration and approval are:

- Specifications for Carbon-Steel and Alloy-Steel Forgings (A18-21)
- Specifications for Quenched and Tempered Carbon-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A19-21)
- Specifications for Carbon-Steel Forgings for Locomotives (A20-21)
- Specifications for Quenched and Tempered Alloy-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A63-21)

Specifications for Carbon-Steel Car and Tender Axles (A21-18).

Specifications A18-21 for Carbon-Steel and Alloy-Steel Forgings are general specifications covering the various classes of carbon-steel and alloy-steel forgings, on which the other specifications have been based with the addition of special requirements to suit the conditions of use. The preparation of these four specifications for forgings dates back to the earliest history of the American Society for Testing Materials. The predecessor of these specifications was the Standard Specifications for Steel Forgings, which were first proposed in 1900 and adopted in 1901 previous to the organization of the present A.S.T.M. by what was then the American Section of the International Association for Testing Materials. Since 1901 there have been several revisions of the work, notably in 1914 with the coöperation of other technical societies and associations, including the former Master Mechanics, Association and the Master Car Builders' Association, now the Mechanical Section of the American Railway Association. The work on alloy-steel forgings other than nickel steel was developed in 1915 as an extension of the previous work.

The specifications for Carbon-Steel Car and Tender Axles, while not included in the forgings series, were developed in connection with this work. In 1914 the Committee of the American Society for Testing Materials in charge of these specifications entered into a coöperative investigation with the Master Car Builders' Association, which led to a revision of the specifications in 1917 that harmonized the requirements in the two organizations. The revised specifications, adopted in 1918, have stood without revision since that date.

In submitting these specifications for approval by the American Engineering Standards Committee, the American Society for Testing Materials has presented data listing the companies, etc. that use them in their entirety or as general specifications upon which have been based other specifications suited to the particular needs. These specifications have been translated by the Department of Commerce into French and Spanish in connection with the development of foreign trade. The revised specifications are contained in the 1921 volume of A.S.T.M. Standards.

Two Cold-Drawn Steel Specifications

The A.E.S.C. has now before it for consideration and approval A.S.-T.M. Standard Specifications for Cold-Drawn Bessemer Steel Automatic Screw Stock (A32-14), and Cold-Drawn Open-Hearth Steel Automatic Screw Stock (54-15).

The materials covered in the two specifications are intended for use in making machine parts in automatic and other rapid-cutting machines in which the highest cutting efficiency is sought, consistent with the nature of the metal specified.

The history of the preparation of these specifications dates from 1909 when a committee was organized by the American Society for Testing Materials to prepare standard specifications for cold-drawn steel. In the discussion of specifications for automatic screw stock it became evident that considerable data were required, particularly with reference to material used for machining at very high speed. The committee accordingly undertook a series of tests to determine features which would affect the working qualities and physical characteristics of standard automatic screw stock. The various consumers represented on the committee placed orders with each of the producers for cold-drawn steel for automatic screw-machine work for test purposes, and a total of about twenty tons of material was thus furnished and tested. These tests were completed in 1913. The specifications covering bessemer stock were adopted by the society in 1914, and, after revision, the specifications for open-hearth stock were adopted in 1915. There have been no revisions since adoption.

These specifications have been translated by the Department of Commerce into French and Spanish for distribution in connection with the development of foreign trade. These specifications may be found in the 1918 volume of A.S.T.M. Standards.

Standard for Permissible Explosives

Standard Specifications for the Testing and Use of Permissible Explosives for Use in Mines, Bureau of Mines Schedule 17, are now submitted for consideration and approval as Tentative American Standards.

These standards are the result of thirteen years' experience by the Bureau of Mines in testing and in assisting manufacturers to develop explosives which offer the minimum hazard, when properly used, in gaseous and dusty mines.

In September 1908, the Bureau of Mines established laboratories, which maintain a trained corps of chemists and engineers conducting routine tests and carrying on special research work to assist in the manufacture and use of explosives. The design of these laboratories, the tests applied to the explosives, and the procedure followed in applying these tests were determined after consultation with the manufacturers and users of explosives in this country and with the officials directing similar tests in England, France, Belgium and Germany.

Standard methods of testing explosives were first published by the U. S. Geological Survey as Explosives Circular No. 1 on May 15, 1909, together with the first list of 17 permissible explosives.

By 1915 data on the testing of upward of 200 explosives had been accumulated, and 134 explosives had been placed on the permissible list. In June 1915 the Bureau of Mines called a conference of representatives of manufacturers of explosives to discuss the methods of testing employed and to determine the tolerances to be permitted in the retesting of field or of manufacturers' samples. As a result of this conference series of tolerances were issued on July 1, 1915.

In November 1920, the Bureau of Mines reviewed the rules and regulations then governing the testing and placing of explosives on the permissible list. In this review the committee took into consideration the data accumulated in the testing of 290 different explosive materials, of which 195 had been classed as permissible. The revised rules formulated as a result of this study were submitted to the explosives manufacturers of the country for their comment and criticism. With these comments in hand a final revision was made and approved as Schedule 17 on April 8, 1921.

Preferred Numbers

As an illustration of a fundamental piece of standardization work based on theoretical considerations which the Germans are attempting, a brief description of their system of "preferred numbers" may be of interest. This is a system of logically-worked-out numbers which are recommended for all new standardization work where numerical values are required. This includes dimensional work, such as the diameters of pulleys and thicknesses of plates, and also for numerical values of speeds, capacities of apparatus, such as kilowatt ratings of motors, etc.

In the accompanying table are given the more important numbers of the system. As an example of their use, if 5 sizes between 10 and 100 mm. are found to be sufficient, the numbers in the first column would be taken, viz., 10, 16, 25, 40, 64 and 100 mm. If 10 are necessary, the numbers in the second column would be chosen. For the range 1 to 10, the decimal would be shifted. A 40 and an 80-series are included in the system, but few cases requiring their use have arisen.

The numbers in each series increase by a constant percentage, i.e., they increase in geometric ratio, or logarithmically, as the diameters in the American Wire Gage. This makes the ratio of the numbers in the 5-series the fifth root of 10, in the 10-series the

tenth root of 10, etc., but rounded to give convenient numbers. The rounded numbers make the use of gage numbers unnecessary.

The Germans regard these preferred numbers as very important as they believe their use will lead to great economies in material, reduce the number of sizes, ranges, etc., simplify the carrying of stocks, facilitate interchangeability, etc.

The following examples of the use of these preferred numbers are from the electrical industry alone: kilowatt ratings of motors, turbo-generators, and transformers; dimensions of carbon brushes; diameters and speeds of pulleys.

TABLE OF PREFERRED NUMBERS

5-Series	10-Series	20-Series
10	10	10
		11.2
	12.5	12.5
		14
16	16	16
		18
	20	20
		22.5
25	25	25
		28
	32	32
		36
40	40	40
		45
	50	50
		56
64	64	64
		72
	80	80
		90
100	100	100

NEWS OF OTHER SOCIETIES

American Institute of Mining and Metallurgical Engineers

The 124th meeting of the American Institute of Mining and Metallurgical Engineers held at Wilkes-Barre, Pa., September 12 to 15, 1921, celebrated the semi-centennial of the Institute, which now has a membership of more than 10,000.

Technical sessions held the first day of the meeting included papers on mining problems, descriptions of plants and coal fields, and several presented under the auspices of the metal section of the Institute, including the following: Application in Rolling of Effects of Carbon, Phosphorus and Manganese on Mechanical Properties of Steel, by W. R. Webster, of Philadelphia; The Thacher Process for Molding and Casting Propeller Blades and Wheels, E. Touceda, metallurgist, Albany, N. Y.; and Acid Open-Hearth Process as Conducted in America, Col. W. P. Barba, Philadelphia, and Dr. H. M. Howe, New York.

The second day of the meeting was spent in an automobile trip through the Wyoming Valley to Scranton, Pa., where the afternoon was devoted to two simultaneous sessions, one dealing largely with electrical features of mining, and the other with Americanization work in connection with mining and metallurgical industries. In the evening another technical session was held at Wilkes-Barre, the subjects under discussion being the Power Installation at Cloverdale, Octagonal Ventilation Shaft of Davis-Daly Copper Co., and the Application of Pulverized Coal to Boilers.

On the following day there was a general joint meeting conducted by the Society of Economic Geologists, a session on mine accounting, a general technical session and an economic geology session, at which many interesting papers were presented.

The meeting closed on September 15 with an all-day excursion to parts of the Wyoming, Lehigh and Southern anthracite coal fields.

Association of Iron and Steel Electrical Engineers

A five-day meeting of the Association of Iron and Steel Electrical Engineers was held at Chicago, September 19 to 24. The technical sessions laid particular emphasis on fuel economy. Standardization also received considerable attention, and an exhibit of electrical devices and inspection trips formed interesting features of the meeting. Only two papers were presented at each session, so that there was ample opportunity for discussion.

The papers dealing with fuel economy were by F. E. Leahy, fuel and experimental engineer of the Carnegie Steel Co., Duquesne, Pa., W. N. Flanagan, steam engineer for the Ohio Works of the Carnegie Steel Co., Youngstown, Ohio, E. A. W. Jefferies, consulting engineer, of Worcester, Mass., and G. R. McDermott, assistant engineer of the Illinois Steel Co., South Chicago, Ill.

Mr. Leahy listed the different forms of fuel used in steel mills, giving the characteristics which fit each one to a different operation, and dealt with possibilities of economy in their transportation, storage and distribution. The discussion brought out the high efficiencies obtained through the use of waste-heat boilers.

The advantages of automatic boiler control were enumerated by Mr. Flanagan, who described one method in which electricity is the controlling medium. The coördination of power from various boilers was believed to be an important factor in conservation of fuel.

The paper by Mr. Jefferies announced his discovery of a method of producing cheap oxygen. This method is based on the idea of carrying on the distillation of the volatile nitrogen from liquid air at the pressure to which the air is originally compressed. The nitrogen, constituting about 80 per cent of the whole volume of the air, may be heated and used in a piston engine to drive the compressor, making external power for operation unnecessary. The applications of this method and the benefits to be derived were discussed.

Mr. McDermott reviewed accomplishments in the utilization of waste gases in steam generation, naming sources of waste heat, and discussed the merits of various types of boilers as absorbers of waste heat.

Other papers presented at the meeting dealt with recent developments in the design of induction-motor starters, the electrification of the steel-mill railroad, and anti-friction bearings in the steel mill.

The report of the Standardization Committee included electric overhead-traveling-crane specifications, general specifications on alternating-current motors for main-roll drives, and a report of the Sub-Committee on Illumination.

The following new officers were elected: Warren S. Hall, Illinois Steel Co., Chicago, president; R. B. Gerhardt, Bethlehem Steel Co., Sparrows Point, Md., first vice-president; L. F. Galbraith, West Penn Steel Co., Brackenridge, Pa., second vice-president; J. F. Kelly, Pittsburgh, Pa., secretary; and James Farrington, LaBelle Iron Works, Steubenville, Ohio, treasurer.

American Society for Steel Treating

At the third annual convention and exhibition of the American Society for Steel Treating, held at Indianapolis, September 19–24, over 40 papers were presented and discussed, and as many more were presented by title. Research and management were subjects placed on the program of the society for the first time.

Carbonizing was the subject of the first technical session and various processes were discussed by several speakers. Simultaneous sessions on tool steel and heat treatment of special products were held the second day, and included papers on physical tests on high-speed steel, brass forgings, and heat treatment of copper and brass.

On the morning of September 22 two simultaneous sessions were held, one on army and navy subjects, including an illustrated paper on railway gun mounts, and one on alloy steel, at which several papers of interest on the mechanical properties of various alloy steels were presented. In the afternoon another group of sessions covered the subjects of metallographic research and heat-treating equipment.

Research, management and costs, and heat-treating problems were discussed on the last day of the conference.

Of the new officers elected, Frank P. Gilligan, of the Henry Souther Engineering Co., Hartford, Conn. is president; F. C. Lau, Arrow Forging & Tool Works, Chicago, first vice-president; R. J. Allen, Rolls-Royce Co. of America, Springfield, Mass., second vice-president; J. V. Emmons, Cleveland Twist Drill Co., Cleveland, treasurer; and J. J. Crowe, Philadelphia Navy Yard, director.

In conjunction with the meeting of the steel treaters an exhibition was held in which the products of over 60 manufacturers of metallurgical equipment and heat-treating devices were presented.

Argentine National Engineering Congress

The second Argentine National Engineering Congress was held in Buenos Aires, Argentine, S. A., Sept. 23, 1921, under the auspices of the Centro Nacional de Ingenieros. The conference commemorated the centennial of the founding of the University of

Buenos Aires, and the program included sessions on surveying, architecture, hydraulics, sanitary engineering, industrial engineering, transportation, and general.

The hydraulic session included discussion of irrigation by pumping, and drainage systems in Buenos Aires and the interior.

Water supply, purification and transportation of water, and sanitation in unhealthy districts were discussed at the session on sanitary engineering.

One group of papers discussed at the session on industrial engineering dealt with electrotechnical subjects, including electric and hydroelectric plants, distribution of energy, industrial and domestic applications, electric traction, telegraphy and telephony, electric propulsion of ships, and power supply for electrification of suburban railways. Other groups of papers presented at the industrial session were on such subjects as textiles, woods, paper, cement, brick, glass, refrigeration, liquid and pulverized fuel, mining and metallurgy, rural water and power supplies, etc.

Aeronautical, vehicular, and rail transportation were discussed at length at the session of means of communication and the general session included questions of economics and legal engineering.

The invitation to the American National Engineering Societies in Argentina to send delegates to this conference, was a recognition of this organization which was formed early this year as a result of the activities of Local Sections of the A.S.M.E.

American Electrochemical Society

The fortieth general meeting of the American Electrochemical Society was held at Lake Placid, N. Y., Sept. 29, 30 and Oct. 1. The outstanding feature of the technical program was a symposium on non-ferrous metallurgy, at which two papers were presented dealing with electric furnaces for melting brass and other non-ferrous alloys, namely, The Influence of the Electric Furnace on the Metallurgy of Non-Ferrous Metals, by H. M. St. John, of the Detroit Electric Furnace Co., and Resistance-Type Electric Furnace in the Melting of Brass and other Non-Ferrous Metals by T. F. Baily, of the Electric Furnace Co., Alliance, Ohio. In a paper by N. K. B. Patek, works manager of Lumen Bearing Co., Buffalo, N. Y., electric-furnace practice was compared with fuel-fired-furnace practice. H. A. De Fries, consulting engineer, New York, described an electric silver-melting equipment, and Dr. E. F. Northrup, of the Ajax Electrothermic Corporation, Trenton, N. J., discussed some difficulties met in melting a large quantity of silver. Other papers in the symposium dealt with electric-furnace melting of nickel silver, recent developments in electric furnaces of the muffled-arc type, and modern developments in the British brass industry.

In the general session, a paper on Experiences with Alkaline and Alkaline Earth Metals in Connection with Non-Ferrous Alloys was presented by Charles Vickers, consulting foundry engineer, Buffalo. He stated that sodium was the best of the alkaline metals for use as a deoxidizing agent in making copper castings of superior torsional strength, and that calcium, in combination with an acid element, will produce castings of good electrical conductivity.

The theory that corrosion is started by the formation of colloidal ferrous oxide was discussed in a paper by J. Newton Friend, of Birmingham.

Rust Prevention by Slushing was the title of a paper presented by Haakon Styri, Chief of the S.K.F. Research Laboratory, Philadelphia. This paper emphasized the importance of preventing rust on steel parts which cannot be given a permanent coating of paint or metal.

LIBRARY NOTES AND BOOK REVIEWS

Aeroplane Performance Calculations. By Harris Booth. Dutton & Co., New York, 1921. (The Directly Useful Technical Series.) Cloth, 6 × 9 in., 207 pp., diagrams., $8.

This book, it is hoped, will meet the need of aeronautical engineers and designers for a practical method of calculation; it is in three sections: first, a descriptive and theoretical section explaining the points to be noticed and deriving the necessary formulas; second, an explanation of practical procedure; third, an example of the application of the method described to an actual machine.

Alternating Currents. By Carl Edward Magnusson. Second edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 559 pp., illus., $4.50.

A presentation of the fundamental principles of alternating-current phenomena, with illustrations of their application to industrial problems, intended to aid the student in gaining clear concepts of what actually takes place in alternating-current machinery, to explain the relations between the factors involved and to express the physical facts in mathematical forms in such a manner that he shall understand the equations and be able to use them rationally in the solution of industrial problems.

America's Power Resources. By Chester G. Gilbert and Joseph E. Pogue. The Century Co., New York, 1921. Cloth, 5 × 8 in., 326 pp., illus., $2.50.

An attempt to interpret the importance attaching to the energy resources, coal, oil, natural gas and water power, to point to the shortcomings in the way they are handled, to outline the changes in the administration of energy which are bound to come into play if due social and industrial progress is to be attained, and to indicate the avenues of advance along which constructive efforts should be applied. The material presented is largely the result of investigations by the authors, brought out from time to time as special papers, emanating mostly from the Division of Mineral Technology, United States National Museum, and more popularly presented here in a unified and less technical form.

Automatic Telephony. By Arthur Bessey Smith and Wilson Lee Campbell. Second edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 430 pp., illus., diagrams, $5.

The method adopted is to describe fully the typical circuits and apparatus of the Strowger type, and to outline briefly the other important systems. By this method it has been possible to explain the principles and methods fully enough for their application to other makes of equipment, without attempting to narrate the practice of all manufacturers in detail. This edition is radically changed from the previous one by the elimination of obsolete matter and the introduction of new material.

Electric Furnace. By J. N. Pring. Longmans, Green & Co., New York, 1921. (Monographs on industrial chemistry.) Cloth, 6 × 9 in., 485 pp., plates, illus., $10.50.

Although the most noteworthy branches of the electrochemical and electrometallurgical industries have been described in a number of publications, the present rapid progress of these enterprises demands a frequent revision and extension of the literature. This volume is an additional contribution to the general technical discussion of the position and prospects of high-temperature industrial chemistry. The author reviews the history and principles of the electric furnace and describes the types in use. Current supply, transformers and the measurement of high temperatures are treated and the use of the electric furnace in the metallurgy and chemistry of the important metals is described. Attention is also given to furnace design and to the economic aspects of electrochemical processes. A useful bibliography is appended.

Etude des Mouvements Appliquee. By Frank B. Gilbreth and L. M. Gilbreth. Dunod, Paris, 1921. Paper, 5 × 8 in., 161 pp.

In 1918 Mr. Gilbreth's Motion Study appeared in French. Evidently it attracted interest, for it is now followed by a translation of Applied Motion Study, a collection of papers by Mr. and Mrs. Gilbreth which was published in this country in 1919. The publication of the book is an indication of the keen interest of French engineers and manufacturers in American methods of production.

Grundlagen und Geräte Technischer Längenmessungen. By G. Berndt and H. Schulz. Julius Springer, Berlin, 1921. Paper, 6 × 10 in., 216 pp. illus., 48 M.

This discussion of the principles upon which our measurements of length rest and the instruments used for measurement is intended for engineers and machinists engaged in manufacturing industries. The book first explains the development of the metric system, the standard meter and the methods of reproducing it. The development of industrial measures and gages is then described fully, their exactness discussed and the physiological errors that occur are explained.

Handbook of Standard Details for Engineers, Draftsmen and Students. By Charles H. Hughes. D. Appleton and Co., New York, 1921. Cloth 5 × 7 in., 312 pp., tables, diagrams, $6.

The book is a compilation, in a volume of convenient size, of drawings, tables and formulas of standard details. Included among these are fastenings of various kinds; shafting, clutches, collars, bearings, gearing and other parts of power transmissions; pipes tubes and fittings; rope and chain fittings; structural and miscellaneous details. Much of the material has been furnished by American machine-tool manufacturers and represents their practice.

Heat Treatment of Soft and Medium Steels. By Federico Giolitti. Translated by E. E. Thum and D. G. Vernaet. First edition. McGraw Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 374 pp., illus. $5.

Contents: The Phenomena of Diffusion in Primary Solid Solution; Effects of Diffusion upon Secondary Crystallization; Diffusion in Austenite as Applied to Preliminary Heat Treatment of Steels; Preliminary Heat Treatment of Steel Castings; Preliminary Heat Treatment of Forged and Rolled Steels.

Metallurgists and metallographists, according to the translator of this volume, have only recently been impressed by the fact that various impurities and addition agents may affect the properties of finished steel far in excess of that expected by their apparent amount. Precise data along the lines are almost entirely lacking; therefore this book, containing the first systematic discussion of their effect on commercial heat treatment, should prove a stimulus toward their study as it shows the great advantages to be gained by their elimination or suppression.

Heating Systems. By F. W. Raynes. Second edition. Longmans, Green and Co., New York, 1921. Cloth 6 × 9 in., 324 pp., plates, diagrams, tables, $7.50.

This textbook on the design of heating systems presents modern English practice. A special feature is the large number of charts that have been prepared and the method adopted for calculating pipe sizes. The practical rather than the theoretical aspects of the work have been given attention. Consideration is also given to the economical aspect of heating problems, especially in the heating of industrial buildings and plants. The new edition has been brought up to date.

Induction Motor and Other Alternating-Current Motors. By B. A. Behrend. Second edition, revised and enlarged. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 272 pp., portraits, diagrams, $4.

This work appeared first in 1901 and is based on a series of lectures delivered at the University of Wisconsin during the preceding year. This second edition, twenty years later, has been expanded from 105 to 272 pages and thoroughly revised to represent the author's present opinions on its subject. The book is not meant to be encyclopedic. It is, in the words of the author, "essentially the work of an engineer who has had the good fortune to have been actively associated with the art of electrical engineering through almost three decades and who has had a part in the development of the machines about which he writes."

Traite de Dynamique. By Jean d'Alembert. Gauthier-Villars et Cie, Paris, 1921. (Les maitres de la pensee scientifique.) Paper, 4 × 7 in., 2 vol.

This edition of d'Alembert's work on mechanical philosophy is reprinted from the second edition, which appeared in 1758, and which was enlarged and corrected by the author. It fills the need for an inexpensive, accurate edition of the book.

D'Alembert (1717–1783) was the most prominent student of celestial mechanics between Newton and Laplace. His investigations prepared the way for the Analytical Mechanics of Lagrange.

IMPRESSIONS OF INDUSTRIAL RUSSIA

(Continued from page 751)

man's position was almost unbearably difficult. He was between two fires. On one side was the management committee, made up of a workman from the factory, a former draftsman and an appointee from the central office of the Metal Department. They occupied the elaborately furnished offices of the factory, and gave impractical and impossible orders. The other difficulty was the interference of orders from four automobile departments of the government. The military department gave peremptory orders, saying "Here is an automobile which must be repaired before a certain date or you will be shot."

In addition, the chief engineer was struggling with a thousand untrained, hungry, cold, dejected men; his own family, consisting of wife, two children and a lady relative, were living in two rooms heated by small sheet-iron stoves. He had no automobile and as there was no street-car service he walked to the factory every morning, about 3 or 4 miles. This man went struggling constantly with the personal problem of fuel and food, often dragging supplies home himself on a hand sled. His holidays and evenings were spent in disagreeable, trying physical labor, such as cleaning stoves, sawing and splitting wood, carrying water, etc. On many holidays he went to the factory and joined with labor parties in physical work, removing snow and refuse, and cleaning up the factory.

Education

It is often stated by supporters of the Bolshevik government that while there cannot be very much expected from the present generation of workers trained under capitalistic methods, the generation now being educated will bring about a new industrial day. It is therefore interesting to take a look at this educational system of which they speak.

When one understands the terrible difficulties in the way it is not surprising that there are no results either in education or production. They have quite a beautiful theory of education for all. However, with four years of destruction and no printing except Bolshevik propaganda, there are no schoolbooks and no educational literature. Magazines and books of general educational value are almost entirely lacking. In addition to this, there is not sufficient fuel to heat the school buildings. There is a shortage of teachers, and such simple things as notebooks, slates, lead pencils, pens, ink, etc. are very scarce or entirely lacking.

The universities are open to every one. This makes it extremely difficult for the professors, who try to suit their lectures to the average student body, with the result that they are commonplace for those with preparatory training and unintelligible to the unprepared.

The children are always cold and hungry. There is no adequate provision for taking care of the schoolrooms and keeping them heated and clean, and the students are required to prepare the fuel and clean the buildings.

The main inducement to attend the schools is a noon lunch of a little soup made from cabbage or dried fish, with sometimes a little black bread.

Bolshevik Leaders Hide Economic Failure

The Bolsheviki have been successful in diverting public attention from their economic failure. First they ascribed it to the war and blockade. Following this they lulled the people with much talk of concessions by which they hoped to lure the capitalists of the world into their country and use them as a tool for solving the very difficult situation. The next cry was that of electrification, there were wonderful schemes for electrifying the entire Russian country and an electric train made a trip from Petrograd to Moscow. This was an ordinary storage-battery train, which is, of course, impractical for such service. The latest diversion is feeding the starving. There is no doubt that entire Russia is in danger of starvation, but the Bolsheviki attempt to make it appear that the cause is entirely due to the crop failure. It is true that there has been a crop failure in the lower Volga grain-producing section. In normal times, however, Russia exported large quantities of grain, and had there been a reserve and adequate transport, Russia could have taken care of its population.

What of the Future?

It is almost useless to speculate on what the result will be. But everybody, even the Bolshevik leaders themselves, apparently has come to the conclusion that this gigantic centralized organization scheme cannot succeed. Therefore there is the effort to decentralize and denationalize. Small private business is now permitted and there is much talk of the coming decrees which will give back to the former owners their houses and the smaller factories. But it is difficult to understand how they can be given back to private ownership. First the factory organizations have been destroyed, the stock of raw material and products consumed, and the buildings and equipment are in bad repair. To add to the difficulty of the private owner is the lack of financial machinery which he must have to do business. Lastly, all the liquid wealth of Russia has been destroyed.

In general, there seem to be only two suggested solutions for the present difficulty. One is the violent overthrow of the present government, but this seems impossible with opposition party leaders in jail and their followers under constant surveillance. The other is evolution to capitalistic private ownership. With all the talk of concessions I know of not one single effective concession which has been given. It seems almost impossible to establish a basis on which a concession could be given that would be acceptable to an outside capitalist. It also seems equally impossible to think of a plan by which the Bolshevik and capitalistic ideas can be mixed. Therefore the future of Russian industries is not bright. When reconstruction begins, manufactured products must be bought from the outside for the next one or two generations. Russia will be indeed fortunate if she can take care of her own repair and maintenance.

MAKING WORK FASCINATING AS FIRST STEP TOWARD REDUCING WASTE

(Continued from page 734)

rate of wage based on *time and class* of work and a *secondary* rate of wage based on actual *exercise of skill*, knowledge and intelligence.

A method of compensation of this character stimulates the development and exercise of creative power, encourages elimination of waste and does not suppress the desire to serve. In seeking these aims the fascination is readily found, while the interest in improvements and accomplishments is not pushed to the background by financial uncertainties or worries.

Another notable attempt to combat the evils arising from the lack of interest provided by mechanized work, may be observed in the hopes aroused by certain claims that a careful selection of workers to fit the work will eliminate dissatisfaction created by the poor fitting of men to jobs. These hopes wane as rapidly as they spring into prominence because the selection of men for jobs is an error of lowering a dimension. The correct course would be to fit the jobs to the men—in other words, to elevate the work to human dimensions, requiring not mere physical or animal power but an exercise of creative, intelligent faculties as well. The first step along this road is training the worker,[1] as opposed to securing unambitious, discouraged ones of low intelligence and further degrading them by assigning them to perform the lower functions of beasts of burden.

The next step advocated is to organize the work so that the worker's intelligence and his creative or imitative instincts will be brought into play. This requires (1) analysis of jobs and processes to bring out the interrelation of causes and effects and (2) the education of operators in conscious control of these forces and relations so that they can at will influence the results.

In order to eliminate a major part of our industrial losses, the creative, intelligent impulses of men should be given the fullest opportunity of self-expression. As an ideal we may foresee a complete abolition of monotonous, automatic, repetitive operations performed by men. These should be relegated to machines, while men should assume the part of directors and supervisors of processes. Workers by brain and by hand should unite in inducing relations between causes and effects, which are separated by the time elapsed. *Our imperfect machines, inefficient methods, wasteful processes and monotonous operations are the results of the incomplete, restricted use of our creative capacities.*

[1] Training Workmen, etc., H. L. Gantt.

It is now generally recognized in industry that idle equipment is harmful; the greatest source of waste is to be found in the idleness of our available knowledge and creative capacities of men, which are not liberated and applied productively under the mechanistic, formal organization.

The greatness of a new industrial leader will lie in his ability to liberate the creative forces within men, as against relegating them to the level of animals carrying burden and doing machine-like work.

In the author's experience in promoting and increasing industrial efficiency, he has found that the most fundamental, most successful and most enduring way to do it is in the elevation of man to his true dignity as an intelligent, creative agent. To be specific, the monotonous physical labor of a fireman is readily transfigured by special training into a fascinating game based on the exact sciences of physics and chemistry, requiring an exercise of mental capacities. Watching and interpreting a simple array of instruments (Fig. 3) provides men with interest, which is augmented as they intelligently control a process and watch the results attained.[1]

Charting the progress made in elimination of waste of material provides further source of satisfaction in observing one's own improvement in the mastery of processes through the acquisition of knowledge and skill. These charts (Figs. 4, 5, 6 and 7) are plotted on the basis of what is possible of accomplishment with a proper exercise of intelligence, knowledge, and skill, and the short bars indicate the falling short of possibility. Sometimes it is found that a playful spirit of friendly competition or just pride in self-improvement and accomplishment prompts men to draw similar records on the fronts of their boilers (Fig. 8) or elsewhere in the room. When men find themselves thinking about their job it loses its monotony. Moreover, the amount of physical labor is reduced in some inverse proportion to the intelligence applied.[2]

Similar reorganization of jobs and corresponding transformation of workers' attitude have been successfully tried in a variety of establishments—in the glass industry,[3] pulp and paper mills,[4] foundries, power plants,[5] etc.— and the further application of these principles awaits the progressive coöperation of manufacturers and industrial leaders.

[1] "The object should surely be to make the workman in the future more of a director of instruments than a laborer, and to unite hand and brain as of necessity implying each other." Viscount Haldane of Cloan in introduction to Lord Leverhulme's Six Hour Day, Henry Holt & Co., N. Y., 1919.

[2] In such purely physical work as passing coal and ashes in power houses, this "bringing mind into labor" reduces amount of manual labor often to one half of former. In many cases work was considered so hard that labor turnover exceeded 300–500 per cent; the personnel remained on payroll unchanged for years after these principles were brought into play.

[3] In a glass and mirror factory the writer was able within a few months to develop such interest in the work that in a strictly unionized shop, the men in roughing department increased production 100 per cent and reduced expenses 34 per cent; in emery department the increase was 125 per cent and in surface polishing department 150 per cent with corresponding economies in production despite the fact that men's earnings at the same time increased by payment of 25 per cent bonus; amount of defective work was also reduced to one-fifth of the former.

[4] "This sort of creative efforts produced great changes in operating conditions." R. Wolf tells that in a pulp mill "we increased our yearly production from 42,000 tons to 111,000 tons without adding to the number of digesters for cooking the pulp, or wet machines for handling the finished product and we changed our quality from the poorest to the very best."

[5] In a typical power house of a large and progressive manufacturing concern, application of the writer's principles produced results thus reported by general superintendent to the president: "When the fact is taken into consideration that in the early part of 1918 we were paying \$3.98 per ton delivered for coal, and that today our contract calls for a price of \$5.15—and the market price of power-house labor has increased slightly more than 50 per cent...our unit cost of power has gradually been reduced from a high cost of 1.11 in 1918 to an average less than 0.5, it can be seen that the improvement has been marked." In another instance the new spirit created was reflected in the report of an officer of the company stating that: "Not only have the results of the introduction of the new practice been most gratifying from the standpoint of reduction of expenses to the company and improvement in the conditions affecting the workman and his compensation, but it has also increased the mutual respect between management and workman and has developed the ésprit de corps which is so beneficial to both. The workman is as much interested in the success of the methods which have been established as is the management." J. C. Scholl, Pennsylvania Electric Association, 1915.

THE ENGINEERING INDEX

(Registered U. S. Patent Office and Canadian Patent Office.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENTS

Industrial. Accidents in Factories and Workshops. Chem. Age, vol. 5, no. 112, August 6, 1921, pp. 156–158. Notes on dangers in machinery and processes from annual report of British chief factory inspector.

Reduction of Waste Through Accident Prevention, L. A. DeBlois. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 403–406, 1 fig. Points out importance of careful analysis of industrial accidents in chemical industry.

AERIAL BOMBARDMENT

Course-Setting Bomb Sight. A Course-setting Bomb Sight. Engineer, vol. 132, no. 3425, Aug. 19, 1921, pp. 186–187, 5 figs. Describes latest type of bomb sight, invented by H. E. Wimperis, which permits attack to be delivered at any angle to the wind.

AERODYNAMICS

Stability. Graphic Investigation of Transverse and Lateral Stability (Untersuchung der Querstabilität und Seitenstabilität auf graphischem Weg), A. Baumann. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 14, July 30, 1921, pp. 212–220, 7 figs. Graphic method of investigation is developed based on numerical calculations of Reissner, Gehlen, and others. Importance of graphic investigation for soaring flight.

AEROPLANE ENGINES

Fuel Systems. The K L Fuel System. Aerial Age Wkly., vol. 13, no. 22, August 8, 1921, pp. 515–516, 7 figs. Designed to overcome troublesome features common in complex systems now in use and to completely meet the exacting requirements of aeroplane work.

AEROPLANE PROPELLERS

Air Moved by. Approximate Determination of the Quantity of Air Put in Motion by a Propeller Blade (Détermination Approximative de la Masse d'air que met en Mouvement une Aile d'hélice), Drzewiecki. L'Aerophile, vol. 29, no. 11–12, June 1–15, 1921, pp. 170–173, 3 figs.

AEROPLANES

Aerofoils. The Variation of Aerofoil Lift and Drag Coefficients With Changes in Size and Speed, Walter S. Diehl. Aerial Age Wkly., vol. 13, no. 22, August 8, 1921, pp. 518–520, 8 figs. General statement of principle of dynamic similarity as applied to the problem of determining variation of lift and drag of an aerofoil with size and speed.

Berline Spad. The Berline Spad-Herbemont S 33 (La Berline Spad-Herbemont S 33), E.-H. Lémonon. L'Aerophile, vol. 29, no. 11–12, June 1–15, 1921, pp. 167–169, 2 figs. A new type of six-seater aeroplane fitted with Salmson 250-hp. engine.

Bracing, Internal. The Internal Bracing of Aeroplane Wings, A. H. Stuart. Engineering, vol. 112, no. 2904, Aug. 26, 1921, pp. 301–302, 5 figs. Results of experiments for obtaining suitable data regarding initial tension to be put upon internal bracing wires of wings.

Rieseler. The New Rieseler Sport Monoplane (Das neue kleine Rieseler-Sportflugzeug), E. Meyer. Motorwagen, vol. 24, no. 20, July 20, 1921, pp. 411–414, 4 figs. Characteristics: Span, 7 m.; total length, 5.8 m.; weight empty, 150 kg.; engine, 30-hp. Haacke; speed, 110 km. per hr. Discusses requirements of a sport aeroplane.

Soaring Machine. The Construction of the Soaring Machine of the Baden-Baden Soaring Aeroplane Works, Ltd. (Bauart der Segelflugzeugwerke G.m.b.H. Baden-Baden), F. Wenk. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 14, July 30, 1921, pp. 211–212, 3 figs. Machine is a monoplane with strut and ordinary profile, but with large aspect ration and small surface load. Design is based on achievement of a high inherent stability.

10-Seater Tractor Biplane. Single-Engined Ten-Seater Tractor Biplane. Engineer, vol. 132, no. 3420, July 15, 1921, p. 73, 1 fig. Built by Bristol Aeroplane Co., Ltd., Bristol, England. Span, 54 ft.; length overall, 42, ft.; height, 11 ft.; speed at ground level, 122 mi. per hr.; ceiling, 13,500 ft.

Truss Ribs. Experimental Reinforced Plywood Truss Ribs. Air Service Information Circular, vol. 3, no. 212, April 30, 1921, 17 pp., 17 figs. Description of tests and recommendations.

AIR COMPRESSORS

Explosions. What Causes Explosions in Air Compressors? A. D. Risteen. Can. Machy., vol. 26, no. 6, August 11, 1921, pp. 35–36. Discusses carbonization of oil, ignition of carbon and removal of carbon and oil deposits.

German Types. Compressors (Kompressoren). Schiffbau, vol. 22, no. 42, July 20, 1921, pp. 1040–1043, 5 figs. Notes on Koster's valve gear, single-stage compressors; single-cylinder stage compressor for suction pipes up to 2000 cu.m. output per hr.; tandem compound compressors for suction pipes from 2500 to 5000 output per hr.; and high-speed compressors, built by Frankfort Machine Constr. Corp., Germany.

High-Pressure. A New Design of High-Pressure Compressors. Practical Engr., vol. 64, no. 1795, July 21, 1921, pp. 40–41, 5 figs. Describes Reavell "Axial" single-stage air compressor.

Lubrication. Avoiding Compressor Troubles, A. D. Risteen. Iron Trade Rev., vol. 69, no. 8, Aug. 25, 1921, pp. 489–492 and 495. Lubrication is said to be factor, and oil must have suitable properties. Explosions of external and internal origin can be prevented by cleaning accumulations periodically. Compressors usually over-lubricated.

Reavell Quadruplex. The Reavell Quadruplex Air Compressor and Some Tests Thereon. Engineer, vol. 132, no. 3421, July 22, 1921, pp. 98–100, 9 figs. Report of tests made by H. Riall Sankey on 1920 design.

AIRSHIPS

Inflation. Chart for Inflating Airships (Diagramma dei Lavaggi delle Aereonavi), Angelo Varoli-Piazza. Revista Marittima, vol. 54, no. 6, July 1921, pp. 751–756, 2 figs. Discusses two ways of adding daily a certain quantity of gas and charging completely.

PL 27. The PL 27 Dirigible (Das Luftschiff PL 27). Motorwagen, vol. 24, no. 22, Aug. 10, 1921, pp. 455–460, 7 figs. Built in 1916 by the Aircraft Co. in Bitterfeld, Germany. Specifications: Max. length, 157 m.; diam. 19.6 m.; height, 26.5 m; max. circumference, 61.55 m.; volume, 31,300 cu. m.; useful lift, 18,000 kg.; speed, 27.3 m. per sec. Each nacelle is equipped with a 240-hp. Maybach engine.

ALLOY STEELS

Electric. Three Types of Alloy, Sheet Steel—I, Horace C. Kneer. Iron Age, vol. 108, no. 10, Sept. 8, 1921, pp. 594–596, 2 figs. Deals with investigation of three commercial types of high-strength alloy steel in sheet form, carried out at Naval Aircraft Factory, Philadelphia, to determine which was most suitable for manufacture of fittings for large aircraft.

ALUMINUM

Welding. Oxy-Acetylene Welding Cast and Sheet Aluminum. Can. Machy., vol. 26, no. 4, July 28, 1921, pp. 31–32 and 35. Describes various operations involved.

ALUMINUM ALLOYS

See DURALUMIN.

ASH HANDLING

Methods. The Removal of Ashes in Large Boiler Houses (Ueber die Aschenbeseitigung in grossen Kesselhäusern), Ph. Scholtes. Elektrische Kraftbetriebe u. Bahnen, vol. 19, no. 11, June 10, 1921, pp. 129–133, 9 figs. Account of special meeting of the Bavarian Electrical Works Engineers for study of ash-removal methods. Experiences and costs in different plants with various systems.

Plants. Modern Ash- and Slag-Removal Plants in Boiler Rooms in Rhenish-Westphalian Mines (Neuzeitliche Entaschungs- und Entschlackungsanlagen in Kesselhäusern auf rheinisch-westfälischen Zechen), M. Schimpf. Glückauf, vol. 57, no. 32, Aug. 6, 1921, pp. 761–765, 8 figs. Describes various systems in use.

Railroad Ash-Handling Plant Has Buckets and Crane. Eng. News-Rec., vol. 87, no. 8, Aug. 25, 1921, p. 310, 2 figs. Installation on Burlington railroad designed for economical and direct handling from pits to cars.

Pneumatic Removal of Flue Dust (Pneumatische Flugaschenförderung), F. Ohlmüller. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 3, Jan. 21, 1921, pp. 17–21, 8 figs. Describes a portable ash-removal pump of the Siemens-Schuckert Works with portable vacuum-proof collector in form of a lorry.

AUTOMOBILE ENGINES

Ignition Advance. An Analysis of the Automatic Ignition Advance Mechanism, C. H. Hindl. Automotive Ind., vol. 45, no. 7, August 18, 1921, pp. 312–314, 3 figs. Description and calculation.

Intake Manifolding. Intake Manifolding. Motor Age, vol. 40, no. 7, August 18, 1921, pp. 14–15, 13 figs. Multi-cylinder manifolding as applied to six-cylinder engines.

Lapping Machines for Bearings. Lapping and Running-in Machine, A. B. Bassoff. Machy. (N. Y.), vol. 28, no. 1, Sept. 1921, pp. 5–7, 4 figs. Function of lapping machine. Design of oscillating and of reciprocating mechanism. Types of work lapped.

Starters. Electric Starting Systems for Automobiles (Los Sistemas Eléctricos de Arranque Para Automóviles), F. C. Barton. Boletín de la Asociación Argentina de Electrotécnicos, vol. 7, No. 2, January-

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

February 1921, pp. 12–19, 4 figs. Divides them into those of one unit, two units, and a combination of both. (To be concluded.)

Machining Auto Starter Frames, Robert Mawson. Am. Mach., vol. 55, no. 8, Aug. 25, 1921, pp. 296–298, 15 figs. Practice at plant of Gray & Davis, Inc., Boston, Mass. Special fixtures for drilling and tapping; devices for locating and removing work; boring fixture for polepieces.

AUTOMOBILE FUELS

Exhaust-Gas Odors. Street Hygiene and Automobile Exhaust Gases (Strassenhygiene und Automobilauspuff), Georg Wolff. Gesundheits-Ingenieur, vol. 44, no. 23, June 4, 1921, pp. 271–274. Discusses means of rendering exhaust gases as odorless as possible. Deals with properties of principal automobile fuels—gasoline, benzol (C_6H_6), and benzol and alcohol mixtures—and with lubricating oils.

AUTOMOBILES

A.B.C. The A.B.C. 12 H.P. Light Car. Auto, vol. 26, no. 29, July 21, 1921, pp. 621–625, 9 figs. Made by A.B.C. Motors, Ltd., Walton-on-Thames, Surrey. General description of engine, valve gear, clutch, gearbox, etc.

Daimler. A New Daimler. Autocar, vol. 47, no. 1345, July 30, 1921, pp. 205–207, 8 figs. Describes a 20-hp. 4-cylinder model embodying original details of design.

Durant. Technical Features of New Durant Car, P. M. Heldt. Automotive Ind., vol. 45, no. 7, August 18, 1921, pp. 306–308, 6 figs. Engine is of an overhead valve type and cylinders and top half of crankcase are in single castings.

Generator Armatures. Production Methods in Armature Manufacture, Norman G. Shidle. Automotive Ind., vol. 45, no. 7, August 18, 1921, pp. 318–320, 6 figs. Describes generator armature made by Western Electric Company, Springfield.

Grand Prix, 1921. Prize Competition of the Automobile Club of France (Le Grand-Prix de l'Automobile-Club de France en 1921). Le Génie Civil, vol. 79, no. 6, August 6, 1921, pp. 121–124, 7 figs. Data on the course, and motors and motorcycles competing.

Headlights. Motor Car Headlights: Ideal Requirements and Practical Solutions, A. Garrard. Illuminating Engr., vol. 14, no. 4, April 1921, pp. 92–102 and (discussion) pp. 102–107, 5 figs. Discusses effect of dazzling light on eyes and defines in general terms desirable characteristics of a non-dazzle headlight.

Pilain. The 12-HP. S.L.I.M. (Pilain) (La voiture 12 HP. S.L.I.M. (Pilain)), A. Contet. La Vie Automobile, vol. 17, no. 735, August 10, 1921, pp. 279–283, 10 figs. Details of construction of automobile, a new model by the Société lyonnaise d'industrie mécanique.

Schneider. The 16–20 HP. Schneider. Auto, vol. 26, no. 32, August 11, 1921, pp. 687–690, 9 figs. A French 4-cylinder car, produced by Th. Schneider, Besançon.

Shock Absorption. The Shock Absorption of Automobiles (Bemerkungen zur Abfederung der Motorwagen), H. Reissner. Motorwagen, vol. 24, no. 17, June 20, 1921, pp. 339–343, 5 figs. Based on given calculations, writer seeks to show that light cars do not necessarily sustain greater injury or run less smoothly on poor roads than heavy cars, providing the springs are sufficiently flexible and properly placed.

Spyker. The New Six-Cylinder 30/40-HP. Spyker Automobile (Der neue Sechzylinder 30/40 PS-Spyker-Wagen). Motorwagen, vol. 24, no. 22, Aug. 10, 1921, pp. 453–455, 4 figs. Specifications of car built by The Netherlands Automobile and Aeroplane Factory Trompenburg, Amsterdam: Length of body, 2.84 m.; width, 1.04 m.; wheelbase, 3.47 m.; engine, Maybach with 95-mm. bore and 135 mm. stroke.

Transmission Gears. Machining the Wrigley Automobile Transmission Gear—III, I. William Chubb. Am. Mach., vol. 55, no. 9, Sept. 1, 1921, pp. 333–338, 21 figs. Machining operations of gear frame and axle parts. Assembling gear frame. Methods of checking up different parts.

AVIATION

Aeronautic Roads. Aeronautic Roads, Story B. Ladd. Aerial Age Wkly., vol. 13, no. 24, August 22, 1921, pp. 563–564, 5 figs. Discusses question of road signs and explains block system illustrated by a map of U. S.

Civil. Aviation and Transport, F. H. Sykes. Jl. Inst. of Transport, vol. 2, no. 5, March 1921, pp. 208–216 and (discussion) pp. 216–218. Discusses military and commercial importance of developing civil aviation.

High-Altitude Aircraft. The High-Altitude Aircraft of the Future (Das Höhenflugzeug der Zukunft), C. Eberhardt. Motorwagen, vol. 24, no. 20, July 20, 1921, pp. 405–408, 3 figs. Points out chief differences in use of dirigibles and giant aeroplanes for long-distance voyages, and maintains that for long trips only the dirigible is capable of traveling the shortest route without stop.

[See also FLIGHT.]

B

BALANCING

Principles. Four Years of Balancing Practice, N. W. Akimoff. Eng. & Ind. Management, vol. 6, no. 5, August 4, 1921, pp. 116–118, 4 figs. Describes principles of static and dynamic balance.

BALLISTICS

Corrections. New Ballistic Corrections, Alan S. Hawkesworth. U. S. Naval Inst. Proc., vol. 47, no. 222, August 1921, pp. 1233–1249. Discusses the five points: (1) Corrections of gravity for latitude, (2) curvature of earth, (3) westerly drift of projectile, (4) drift toward equator and (5) alteration in projectile's weight.

BALLOONING

Transatlantic. Historical Study of Attempts to Cross the Atlantic in a Balloon (Étude Historique sur les Projets de Traversée de l'Atlantique en Ballon), Charles Dollfus. L'Aeronautique, vol. 1, no. 9, February 1920, pp. 380–386, 9 figs. Describes attempts of Green, Zeise, Lowe, Wise and Donaldson, Godard, Suchard, Wellman, etc.

BEAMS

Reinforced-Concrete. Reinforced-concrete Beams—III, T. C. Broom. Mech. Wld., vol. 52, no. 1805, August 5, 1921, pp. 108, 1 fig. Discusses chart for concrete T-beam with single reinforcement. (Concluded.)

Unsymmetrical Sections. Calculating the Strength of Unsymmetrical Sections. Machinery (Lond.), vol. 18, no. 463, August 11, 1921, pp. 575–577, 2 figs. Two methods of determining moment of inertia, together with formulas for obtaining section modulus and radius of gyration.

BEARINGS

Spherical. Boring Spherical Bearing Housing, J. Blakey and J. Shankey. Mech. Wld., vol. 52, no. 1805, August 5, 1921, pp. 98, 2 figs. Describes economical method of boring spherical bearing housing for shaft connection between gear box and differential gear of heavy motor transport.

BEARINGS, BALL

Friction. The Ball Bearing: In the Making, Under Test, and On Service, Henry L. Heathcote. Mech. Wld., vol. 70, nos. 1804 and 1807, July 29 and Aug. 19, 1921, pp. 79–81, 4 figs., and 140–141, 2 figs. Discusses questions of friction due to slip, position of non-slip bands, internal stresses due to alternating load. Friction and heat at contact surfaces of ball and race ways of a thrust washer. Paper before Instn. Automobile Engrs. (To be continued.)

BENDING MACHINES

Plate. Plate-Bending Machines (Abkantmaschinen). Schiffbau, vol. 22, no. 41, July 13, 1921, pp. 1000–1001, 6 figs. Details of hand-operated and power-operated machines constructed by L. Schuler Machine Works, Göppingen, Germany, for shaping plates.

BENZOL

Recovery. Present and Future of the Gas Industry. Benzol Recovery (L'Etat Actuel et l'Avenir de l'Industrie Gaziere. La Recuperation du Benzol), A. Grebel. Bulletin de la Societe d'Encouragement pour l'Industrie Nationale, vol. 133, no. 6, June 1921, pp. 602–638, 12 figs. Discusses distillation of coal, and production of by-products, and especially recovery and treatment of benzol.

BLAST FURNACES

Charging Installations. Blast-Furnace Charging Installations (Ueber Hochofenbegichtungsanlagen) Stahl u. Eisen, vol. 41, nos. 28, 29 and 31, July 14, 21 and Aug. 4, 1921, pp. 945–954, 994–999 and 1064–1071, 28 figs. July 14: Practice at the Rhenish Steel Works, Duisburg-Meiderich, by H. Lent July 21: Practice of the Bochum Assn., Bochum. Aug. 4: Blast-furnace department of the Gelsenkirchen Min. Corp. Gelsenkirchen. Report of the blast furnace committee of the Assn. German Iron-Metallurgical Engrs.

Improvement Possibilities. Secure Place of the Iron Blast Furnace, Joseph F. Shagden. Iron Age, vol. 108, no. 8, Aug. 25, 1921, pp. 465–467, 2 figs. Features of superiority not met by processes aiming at producing steel direct from ore. Several possibilities of improvements.

Rating Capacities. Rating Blast Furnace Capacities Charles R. Peebles and R. H. Sweetser. Iron Trade Rev., vol. 69, no. 7, Aug. 18, 1921, pp. 430–432. Southern Ohio Pig Iron and Coke Assn. concludes that furnace should burn 60 lb. of coke in 24 hr. for each cubic foot of working volume. Actual stack data is said to verify this figure.

BLOWERS

Gas-Engine-Driven. Gas Engines and Blowers (Les Moteurs a Gaz et Machines Soufflantes de Grande Puissance, Système Galloway). Le Génie Civil, vol. 79, no. 7, August 13, 1921, pp. 141–145, 11 figs. Discusses the Galloway type of engine (1330 hp.) and blower as applied in metallurgical works.

BOILER EXPLOSIONS

Hydraulic Tests as Safeguard. The Value of Hydraulic Tests as a Safeguard Against Explosions. C. E. Stromeyer. Eng. & Indus. Management, vol. 6, no. 7, Aug. 18, 1921, pp. 170–173. (Abstract.) Annual memorandum of Manchester Steam Users' Assn. Analysis of all reported boiler explosions and conclusions therefrom.

BOILER FEEDWATER

Distilled. Economical Production of Distilled Feedwater for Power Station Boilers (Production économique de l'eau distillée pour l'alimentation des chaudières dans les centrales thermiques), M. Lebard. Chaleur et Industrie, vol. 2, no. 15, July 1921, pp. 402–404 and (discussion) pp. 405. Describes system specially studied. Discusses first cost and saving effected.

Regulators. Scientific Boiler Feed Water Regulation. Can it be Attained in Practice?, Roland Moeller. Am. Mar. Engr., vol. 16, no. 11, June 1921, pp. 30–33, 6 figs. Discusses operation of boiler-feed regulators and their adaptation to demand for steam.

Water Levels and Boiler-Feed Regulators (Neuere Wasserstände und Wasserstandsregler für Dampfkessel), M. Kuhlmann. Glückauf, vol. 57, no. 25, June 18, 1921, pp. 581–584, 7 figs. Describes and recommends use of recently devised water gage located nearer boiler-room flow; improved water-level indicator and feed regulator.

Treatment. Modern Arrangements for the Preparation of Boiler Feedwater (Neuzeitliche Einrichtungen zur Erzeugung von Kesselspeisewasser), R. Klein. Zeit. für Dampfkessel u. Maschinenbetried, vol. 44, nos. 4, 5, 6, 7 and 8, Jan. 28, Feb. 4, 11, 18, and 25, 1921, pp. 25–28, 34–37, 41–43, 51–54 and 57–61, 59 figs. Notes on evaporation process and evaporating plant with vapor compressor; exhaust-heat and cooling-water evaporators; purification process with plate boilers; the thermal-chemical purification process; formation of rust through gaseous feedwater; cold and warm distillation; gas protection.

BOILER FIRING

Draft Systems. Natural v. Mechanical Draught for Boiler Plants—I, J. W. Rogers. Mech. Wld., vol. 70, no. 1804, July 29, 1920, pp. 81–82. Discusses natural-draft, induced-draft and forced-draft systems (To be continued.)

Oil-Fired Boilers. Oil Fuel for Boilers Viewed as a Permanent Institution. Mech. Wld., vol. 52, no. 1806, August 12, 1921, pp. 125–126, 3 figs. Discusses salient features necessary for success of oil-fuel application.

BOILER OPERATION

Control. Boiler Control and Apparatus Therefor (Le Contrôle de la Chauffe. Les Appareils de Mesure Servant a ce Contrôle), Paul Frion. Bulletin de la Societe d'Encouragement pour l'Industrie Nationale, vol. 133, no. 6, June 1921, pp. 553–575. Discusses heat balances and various measuring devices to make best possible use of fuel.

Steam-Jet Draft. Calculating a Steam Jet for the Draft of a Boiler (Calcul d'Une Trompe a Vapeur Pour Tirage de Foyer de Générateur, G. Rollet. Arts et Metiers, vol. 74, no. 7, April 1921, pp. 107–113, 6 figs. Explains principle and shows how to calculate maximum efficiency.

Steam Raising. Steam Raising, David Wilson. Elec. Rev., (Lond.), vol. 89, no. 2280, August 5, 1921, pp. 195–196. Discusses efficiency, liquid fuel, air heaters, etc. (Abstract.) Paper read before Incorporated Mun. Elec. Assn.

BOILERS

Corrosion. The Carbon Dioxide Steam as Cause of Corrosion in Steam Power Engines (Kohlensäure des Dampfes als Ursache der in den Dampfkraftmaschinen auftretenden Korrosionen), Ch. Chorower. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 7, Feb. 18, 1921, pp. 49–50. Methods for determining CO_2 content in steam and means of preventing corrosion therefrom.

Electrically Heated. Electric Steam Generators Automatically Controlled (Générateurs Électriques de Vapeur a Régulateur Automatique de Production), J. Besson-Grange. Arts et Metiers, vol. 74, no. 7, April 1921, pp. 114–116, 3 figs. Description of an electric boiler.

BOILERS, WATER-TUBE

High-Capacity. Tests with High-Capacity Boiler-Tube Nests (Versuche mit Hochleistungs-Wasserrohrbündeln), F. Ebel. Glückauf, vol. 57, no. 29, July 16, 1921, pp. 681–687. Discusses increasing of boiler surface by means of boiler-tube nest. Results of numerous tests and conclusions therefrom.

BRASS

Season Cracking. The Season-Cracking of Brass and Other Copper Alloys, H. Moore, S. Beckinsale and Clarice E. Mallison. Engineering, vol. 112, nos. 2903 and 2904, Aug. 19 and 26, 1921, pp. 297–299 and 327–331, 17 figs. Effects of corrosive and other substances on stressed brass. Action of mercury and ammonia on brass and use of mercury for detection of stress. Influence of composition of copper alloys on season-cracking. (Concluded.) (Abstract.) Paper read before Isnt. Metals.

BROACHES

Design. Practical Design of Broaches, C. S. Pettit. Machinery, (Lond.), vol. 18, no. 462, August 4, 1921, pp. 538–541, 5 figs.

Theoretical Design of Broaches, C. S. Pettit. Machinery, (Lond.), vol. 18, no. 464, August 18, 1921, pp. 602–603, 3 figs. Discusses construction of a broach tooth.

BUCKET ELEVATORS

Improvements. New Types of Bucket Elevator Unloaders for Handling Coal (Neue Anwendungsformen des Becherwerkentladers für Kohlengutförderung), Hubert Hermanns. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 21, May 27, 1921, pp. 161–163, 9 figs. Details of recent developments by Heinzelmann & Sparmberg, Hannover, Germany.

BUILDING CONSTRUCTION

Structural Design. Special Structural Design for Newspaper Building. Eng. News-Rec., vol. 87, no. 10, Sept. 8, 1921, p. 412, 1 fig. Lower chord of steel roof trusses will form future floor reinforcement. Units loads varied on floors. Other details of new reinforced-concrete building for South Bend Tribune.

Wood Construction. Modern Wood Construction Methods (Ueber moderne Holzbauweisen), Hugo

Ritter. Schweizerische Bauzeitung, vol. 78, nos. 5 and 6, July 30 and Aug. 6, 1921, pp. 53–56 and 66–69, 14 figs. Describes various systems and discusses fundamental ideas on which different methods are based.

C

CABLEWAYS

Tension Device. The Tensions in Cableways and Chain-Ropeways with Several Driving Sheaves and Their Regulation by Means of the Ohnesorge Compensator (Die Zugspannungen an Seil- und Kettenbahnen mit mehrern Treibrillen und ihre Reglung durch den Ausgleicher von Ohnesorge), R. Goetze. Glückauf, vol. 57, no. 17, Apr. 23, 1921, pp. 385–391, 16 figs. Construction and operation of the Ohnesorge tension compensator.

CALORIMETERS

Testing Liquid Fuels. The Calorimetry of Liquid Fuel. Eng. & Indus. Management, vol. 6, no. 4, July 28, 1921, pp. 95–96, 1 fig. Results of tests with the Sarco calorimeter constructed on Mahler-Donkin bomb system.

CANVAS

Water Resistance of. The Water Resistance of Treated Canvas during Continuous Exposure to Weather, F. P. Veitch and T. D. Jarrell. Jl. Ind. & Eng. Chem., vol. 13, no. 8, August 1921, pp. 672–676, 2 figs. Results of experiments with 12 oz. U. S. Standard army gray duck.

CAR LIGHTING

Electric. Electric Train Lighting By a Three-Brush Dynamo (Éclairage Electrique des Trains par la Dynamo a Trois Balai), S. Iglesis. Arts et Métiers, vol. 74, no. 7, April 1921, pp. 117–125, 17 figs. Describes Stone-Lilliput and Leitner systems.

CARBURETORS

Asmo. The Asmo Carburetor (Der Asmo-Vergaser), C. Wirsum. Motorwagen, vol. 24, no. 17, June 20, 1921, pp. 346–349, 9 figs. Carburetor invented by Gustav Erikson, Upsala, Sweden, draws up fuel automatically from a lower tank, thereby eliminating use of air pumps, pressure valves, etc. Results of tests demonstrate its economy in comparison with other well-known carburetors.

Developments. The Further Development of Internal-Combustion Engines (Beitrag zur Weiterentwicklung der Verbrennungs-Kraftmaschinen), F. E. Beilefeld. Oel- u. Gasmaschine, vol. 18, no. 7, July 1921, pp. 110–115, 23 figs. Supplementary to article on carburetor problems by Gg. Bergmann in same journal (no. 3, 1921, p. 40).

CARS

Dining. New Dining and Kitchen Carriages for the London-Glasgow Service, Midland and G. & S. W. Railways. Ry. Engr., vol. 42, no. 499, August 1921, pp. 294, 13 figs. Shows improvements in design construction and equipment.

Mine. Loading Machines for Mining Practice (Lastningsmaskiner för underjordisk gruvbrytning), Robert Höök. Jernkontorets Annaler, vol. 105, no. 2, 1921, pp. 97–109, 14 figs. Describes American car loaders, shoveling machines, etc. for underground work.

Motion Recorder. An Automatic Recorder of Vehicular Motion (Indicateur automatique du mouvement des véhicules), E. J. F. Vachet. L'Electricien, vol. 52, no. 1282, August 15, 1921, pp. 367–370, 4 figs. Describes device recording motion of railroad cars and other vehicles, made by Elliot Bros., London.

CASE-HARDENING

Compounds. Carbonizing and Carbonizing Materials, H. B. Knowlton. Trans. Am. Soc. For Steel Treating, vol. 1, no. 11, August 1921, pp. 689–698. Discusses case-hardening and case-hardening compounds.

CEMENT

Bulk. An Investigation into the Use of Bulk Cement. Eng. News-Rec., vol. 87, no. 8, Aug. 25, 1921, pp. 324–326. Discussion of its use on large concrete building jobs, prepared by staff of Turner Constr. Co., New York City.

CEMENT MANUFACTURE

Rotary-Grate Shaft Kilns. The Automatic Rotary-Grate Shaft Kiln, C. F. Hansen. Rock Products, vol. 24, no. 18, Aug. 27, 1921, pp. 33–40, 14 figs. How European portland-cement manufacturers are meeting rapidly increasing fuel and labor costs. Summarizes savings in cement plant with yearly output of 300,000 bbl. in using rotary-grate shaft kilns instead of rotary kiln.

CEMENT MILLS

Hungary. A Cement Mill in Torda, Hungary (Die Zementfabrik in Torda), Hugó Székely and Ernst Havas. Beton u. Eisen, vol. 20, nos. 4–5, 6 and 7–8, Mar. 7, Apr. 4 and May 4, 1921, pp. 41–43, 66–69 and 87–90, 35 figs. Description of cement mill operated with natural gas, and manufacturing process. Details of reinforced-concrete structures of plant.

CHUCKS

Magnetic. Electromagnetic Fastening of Large Workpieces on Planing and Surface-Grinding Machines (Elektromagnetische Aufspannung Grösserer Werkstücke auf Hobel- und Flächenschleifmaschinen), A. W. Schultz. Werkstattstechnik, vol. 15, no. 15, Aug. 1, 1921, p. 451, 2 figs. Describes magnetic holding plates of wrought iron having a tensile force of 10 to 12 kg. per sq. cm. as compared to 4 to 5 kg. with use of cast iron or steel casting.

Magnetic Chucks—IX, Ellsworth Sheldon. Am. Mach., vol. 55, no. 10, Sept. 8, 1921, pp. 383–386, 7 figs. Supporting pieces of irregular shape on a magnetic chuck. Testing a chuck to determine its class.

COAL

Carbonization. The Carbonization of Coal at Low Temperature, John Roberts. Iron & Coal Trades Rev., vol. 103, no. 2789, August 12, 1921, pp. 193–196, and Discussion pp. 196. Discusses expansion of coal and its prevention, dealing with swelled coal; essentials of good semi-coke, etc. Paper read before North of Eng. Inst. Min. & Mech. Engrs.

Combustion and Gasification. The Combustion and Gasification of Coal on the Grate (Die Verbrennung und Vergasung von Kohle auf dem Rost), H. Schmolke. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 19, May 13, 1921, pp. 145–147. Notes on development in study of phenomena in connection with combustion or gasification of coal.

Eastern U. S. How Rank of Eastern Coal Change[s] with Location, R. Dawson Hall. Coal Age, vol. 20, no. 7, August 18, 1921, pp. 257–259, 4 figs. Volatile matter and moisture decrease as East is approached, decline of volatile matter starts not far from Pennsylvania-Ohio line.

Preparation. Advances in Preparation of Anthracite, Dever C. Ashmead. Min. & Metallurgy, no. 177, Sept. 1921, pp. 47–48. History of development. Investigation of five methods of cleaning anthracite. (Abstract.) Paper before Am. Inst. Min. & Metallurgical Engrs.

COAL WASHING

Processes. Modern Coal Washing (La Technique Moderne du Lavage des Charbons), C. Berthelot. Chaleur & Industrie, vol. 2, no. 15, July 1921, pp. 393–401, 8 figs. Discusses importance of coal washing from economical standpoint and describes processes and apparatus for the purpose. (To be continued.)

Notes on Coal Washing By Means of "Rhéolaveurs" (Quelques Notes sur le Procédé de Lavage Par "Rhéolaveurs"), A. France-Focquet. Révue Universelle des Mines, vol. 9, no. 1, S. 6, April 1, 1921, pp. 1–13, 8 figs. Discusses operation of washing fines. (To be continued.)

COKE

Blast-Furnace. Characteristics of Blast Furnace Coke (Sur les Caracteristiques du Coke de Haut-Fourneau), Pierre Kersten. Révue Universelle des Mines, vol. 10, no. 1, Series 6, July 1, 1921, pp. 27–34. Describes physical and chemical properties. (To be continued.)

COKE OVENS

By-Product. New Coke-Oven and By-Product Plant at the Acklam Works of the North-Eastern Steel Company, Limited. Iron & Coal Trades Rev., vol. 103, no. 2788, August 5, 1921, pp. 161–164, 6 figs. Description of new plant, consisting of 60 vertical-flued ovens and recovery equipment.

COLUMNS

Eccentric Loading. Eccentric Loading of Bars and Columns, Edward Ingham. Practical Engr., vol. 64, no. 1795, July 21, 1921, pp. 39–40. Discusses formulas for calculating stresses on eccentrically loaded columns.

Pipe. Strength of Pipes as Columns, John S. Watts. Am. Mach., vol. 55, no. 9, Sept. 1, 1921, p. 341, 1 fig. Presents chart for calculating size of pipe necessary to support a given load as a column of given length.

COMBUSTION

Control. Controlling Combustion on Basis of CO_2 Alone Unsatisfactory. Am. Mar. Engr., vol. 16, no. 11, June 1921, pp. 35–41, 4 figs. Discusses essentials in attainment of maximum economy in combustion control. (To be continued.)

Preheated Air for. The Importance of Heated Combustion Air for Conservation of Coal in Germany (Die Bedeutung der erhitzten Verbrennungsluft für Deutschlands Kohlenwirtschaft), Eugen Haber. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 23, June 10, 1921, pp. 179–181, 3 figs. Discussion of advantages of use of heated air for furnaces.

COMPASSES

Aerial Navigation. Compass for Aerial Navigation (Le Compas de Navigation Aerienne), L. Condroyer. L'Aéronautique, vol. 1, no. 9, February 1920, pp. 387–395, 20 figs. Describes Kelvin, Greach-Osborne and A.M.-1 Compasses.

Gyrostatic. The Anschütz and Sperry Gyrostatic Compasses (Sur les compas gyrostatiques Anschütz et Sperry), H. Beghin. Comptes rendus de l'Académie des Sciences, vol. 173, no. 5, August 1, 1921, pp. 288–290. Discusses equations governing their small oscillations.

CONCRETE

Centrifugally Cast. Centrifugal Machine Casts Solid Concrete Shapes, Leon Cammen. Eng. News-Rec., vol. 87, no. 9, Sept. 1, 1921, p. 366, 1 fig. Describes machine for centrifugal casting of solid concrete shapes, patented by Cammen Laboratories, New York.

Disintegration in Alkali Soils. The Disintegration of Concrete in Alkali Soils, G. M. Williams. Jl. Eng. Inst. Can., vol. 4, no. 8, Aug. 1921, pp. 446–455, 8 figs. Summary of results of laboratory studies together with details of Bur. of Standards field investigations.

Specifications. Tentative Specifications for Concrete and Reinforced Concrete. Proc. Am. Soc. Civ. Engrs., vol. 47, no. 6, Aug. 1921, pp. 60–124, 18 figs. Report of joint committee on standard specifications for concrete and reinforced concrete. Notes on proportioning and mixing, and depositing concrete; forms; details of construction; water-proofing and protective treatment; surface finish; and design.

Strength. Effect of Age on Strength of Concrete, Duff A. Abrams. Mun. & County Eng., vol. 61, no. 2, August 1921, pp. 47–49, 2 figs. Defends view that concrete does not decrease in strength with age.

CONCRETE, REINFORCED

Sea Water, Use in. The Use of Reinforced-Concrete in or Near Sea Water, Arthur S. Tuttle. Mun. Engrs. Jl., vol. 7, 2nd quarterly issue, 1921, pp. 66–84. Suggests rules to ensure reliable results with reinforced concrete in sea water. Reprint of report to Board of Estimate and Apportionment of N. Y. C.

CONDENSERS, STEAM

Leakage Detection. Simplified Chemical Method of Detecting Surface Condenser Leakage, W. E. Caldwell. Power, vol. 54, no. 4, July 26, 1921, pp. 141–142, 1 fig. Tells how to make up solutions for estimating amount of leakage of raw water into condenser.

The Electrical Method of Detecting Surface Condenser Leakage, W. E. Caldwell. Power, vol. 54, no. 6, Aug. 9, 1921, pp. 217–219, 7 figs. Method of obtaining continuous graphic record of leakage by measuring and recording electrical conductivity of condensate.

Surface. Marine Surface Condensers and Condenser Auxiliaries. Am. Mar. Engr., vol. 16, nos. 10 and 11, May and June 1921, pp. 28–33, 6 figs., and 23–27, 17 figs. May: Contains diagrams showing theoretical ratio of injection water of steam for different vacua and water temperatures, also maximum permissible air leakage for different sizes of marine turbine and reciprocating engine condensing plants. June: Discusses live-steam, back-pressure and condensate pumps.

Recent Improvements in Condensers for Steam Engines (Recents perfectionnements des appareils de condensation des machines a vapeur d'eau) L. Jauch. Chaleur et Industrie, vol. 2, no. 15, July 1921, pp. 416–418, 1 fig. Discusses surface condensers, including Brown-Boveri type. (To be continued.)

CONNECTING RODS

Aluminum. Aluminum Connecting Rods (Bielles en Aluminium), A. Dat. Arts et Metiers, vol. 74, no. 8, May 1921, pp. 141–144, 9 figs. Details of construction, alloys suitable, etc.

Machining Automobile. Milling Automobile Connecting-rods, J. M. Henry. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1104–1105, 4 figs. Equipment and methods used in machining Chevrolet, Hinkley and Duesenberg connecting rods.

CONVEYORS

Belt. Belt Conveyor System in Chicago's New Parcel-Post Station. Belting vol. 19, no. 2, August 1921, pp. 17–20, 4 figs. Eighteen conveyors, compactly arranged in tiers, afford quick and efficient separation and distribution to pouches.

Metal Belts. Metal Conveyor Belts with Wide Joint Support (Metallförderbänder mit breiter Gelenkauflage). Fördertechnik u. Frachtverkehr, vol. 14, no. 1, Jan. 7, 1921, pp. 11–12, 6 figs. Describes belt patented by Louis Herrmann, Dresden, with which 95 to 97 per cent of width of link pin is utilized as supporting surface.

COPPER

Sheet. Sheet Copper and Its Sphere of Usefulness, B. Goldsmith. Raw Material, vol. 4, no. 8, August 1921, pp. 268–272, 7 figs. Discusses technical production, prices, and the many uses of sheet copper.

COST ACCOUNTING

Defects in. What is Wrong With Cost Accounting? G. Charter Harrison. Management Eng., vol. 1, no. 1, July 1921, pp. 29–32. Defects of present methods.

Manufacturing Cost. The Elements in Manufacturing Cost, Frederic H. Leland. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 87–88. Discusses three groups of manufacturing costs, namely, general plant expenses, foundry cost and expenses, and manufacturing departments costs and expenses.

COST SYSTEMS

Modern. Disclosing Waste Through Better Cost Methods, Ernest J. Wessen. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 389–393. Claims that many industrial failures are traceable to blind dependence on cost determined by rule-of-thumb methods. Modern cost systems disclose waste in unprofitable products, idle labor and machinery and erroneous methods.

CRANES

Floating. A 60-Ton Self-Propelling Floating Crane. Engineer, vol. 132, no. 3420, July 15, 1921, pp. 72–73, 2 figs. Also in Shipbldg. & Shipg. Rec., vol. 18, no. 6, Aug. 11, 1921, p. 181. Slewing and derricking type of crane built by Werf Gusto (Firma A. F. Smulders), Schiedam, Holland, for Manchester Ship Canal Co.

CRANKCASES

Machining Operations. Machining the Peerless Upper Crankcase, Fred H. Colvin. Am. Mach., vol. 55, no. 10, Sept. 8, 1921, pp. 376–380, 20 figs. Method of handling upper or main crankcase in

shop of Peerless Motor Car Co. Sequence of operations. Inspection gages.

CRANKPINS

Machine for Turning. A New Crankpin Turning Machine. Eng. Production, vol. 3, no. 46, Aug. 18, 1921, pp. 155–156, 3 figs. Mechanism of machine designed for economical production, constructed by George Richards & Co., Ltd., Manchester, England.

CUPOLAS

Smelting Process, Regulation of. Cupola Practice (Beiträge zur Kenntnis des Kuppelofenbetriebes), Fritz Braun and Georg Hollender. Stahl u. Eisen, vol. 41, no. 30, July 28, 1921, pp. 1021–1027, 9 figs. Shows how, with aid of diagrams obtained from self-recording blast-capacity measurements, it is possible, with use of blast-furnace-gas investigations, to regulate smelting process of cupola. A graphic method is described for determining maximum CO_2 content of blast-furnace gases.

CYLINDERS

Boring. Cylinder Boring. Eng. Production, vol. 3, no. 45, August 11, 1921, pp. 127–132, 17 figs. Discusses principles and practice.

Calculation of Wall Strength. Graphic Determination of the Strength of Walls in Hollow Bodies (Graphische Bestimmung von Wandstäaken bei Hohlkörpern), Arthur Balog. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 4, Jan. 28, 1921, pp. 28–29. Describes method applicable to hollow cylinders with internal pressure.

Thick. The Thickness of Hydraulic Cylinders, H. S. Cattermole. Mech. Wld., vol. 52, no. 1805, August 5, 1921, pp. 102–103, 1 fig. Discusses well-known fact that thick cylinders are not as strong relatively as thin ones.

D

DIES

Die-Sinking Machines. Keller Automatic Die Sinking Machine. Am. Mach., vol. 55, no. 10, Sept. 8, 1921, pp. 389–390, 6 figs. All movements electrically controlled; inexpensive masters of wood or plaster used; tracer bears lightly on master, while cutter works under pressure.

DIESEL ENGINES

Appraising. Appraising the Diesel Engine Plant, Allen F. Brewer. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 172–176, 4 figs. Important features that must be considered and analyzed. Calculation and estimation of cost data and depreciation.

Damaged Shafts. Damages to Shafts in Diesel Engines (Wellenbeschädigungen an Dieselmaschinen), Arthur Balog. Zeit. fur Dampfkessel u. Maschinenbetrieb, vol. 44, no. 20, May 20, 1921, pp. 153–154, 9 figs. Discusses examples of breaks in shafts of Diesel engines and their causes.

German Submarine. U-Boat Oil Engines and Recent Developments of the Diesel Engine (U-Boot-Oelmaschinen und neuere Entwicklungsformen der Dieselmaschine), H. Rohwer. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 9 and 10, Mar. 4 and 11, 1921, pp. 65–67 and 74–77, 14 figs. Discussion of different types and improvements by Körting Bros., Benz, Nürnberg-Augsburg Machine Works, Germania Shipyards, etc.

Marine. Marine Diesel Engine Operation (La Condite des Moteurs Diesel Marins), Le Gallou. Bulletin Technique du Bureau Veritas, vol. 3, no. 6, June 1921, pp. 138–142, 4 figs. Continuation of discussion on causes of bad performances. (To be continued.)

Modern Marine Oil Engines—II–VI. Engineer, vol. 132, nos. 3418, 3420, 3422, 3423, and 3424, July 1, 15 and 29, Aug. 5 and 12, 1921, pp. 2–3, 4 figs., 55–57, 11 figs., 109–111, 6 figs., 136–137, 3 figs. and 174–176, 6 figs. July 1: New type 3200-i.hp. Harland & Wolff Diesel marine engine. July 15: Vickers 1250-b.hp. type. July 29: North British 2330-i.hp. type. Aug. 5: 1400-i.hp. Werkspoor type. Aug. 12: 1250-b.hp. Sulzer 2-cycle engine.

Notes on the Management of Marine Diesels, Homer McCrirrick. Marine Eng. of Can., vol. 11, no. 7, July 1921, pp. 10–14, 6 figs. Compares four-cycle and two-cycle diesels and discusses various features in detail.

Problems in the Manufacture of Marine Diesel Engines. Machinery (Lond.), vol. 18, no. 461, July 28, 1921, pp. 513–514, 4 figs. Choice of material and methods of machining Diesel-engine parts.

DRILLING MACHINES

Portable. Portable Drilling Practice—IX. Mech. Wld., vol. 52, no. 1807, August 19, 1921, pp. 138–139, 2 figs. Discusses vertical- and horizontal-spindle machine made by W. Asquith, Ltd., Halifax. (Concluded.)

DROP FORGING

Dies. Design and Making of Drop-forging Dies. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1141–1144, and vol. 28, no. 1, Sept. 1921, pp. 33–36, 12 figs. Methods employed in modern drop-forging plants.

DRYING PLANTS

Precalculation. The Precalculation of Drying Plants with Special Regard to Duration of Drying Process (Die Vorausberechnung von Trockenanlagen, unter besonderer Berücksichtigung der Trockendauer, M. Hirsch. Gesundheits-Ingenieur, vol. 44, no. 29, July 16, 1921, pp. 357–360, 7 figs. Formulas and curves are derived based on investigations and their application is shown in numerical examples.

DURALUMIN

Properties. Light Aluminum Alloys (Alliages Legérs d'Aluminium), J. Dyrion. La Houille Blanche, vol. 20, no. 53–54, May-June 1921, pp. 109–113, 5 figs. Discusses properties, composition and manufacture of duralumin. (To be continued.)

E

ECONOMIZERS

Kablitz. The Kablitz Small-Water-Space Economizer (Der Kleinwasseraum-Ekonomiser Bauart Kablitz), Harry Fahrbach. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 12, Mar. 25, 1921, pp. 89–92, 11 figs. Notes on design and uses of the Kablitz economizer, and results of tests carried out by Kirsch in 1910–12 in the boiler laboratory of Mechanical Institute of Moscow Technical Academy.

EDUCATION, ENGINEERING

Improvements in Training. The College Trained Engineer, C. Edward Magnusson. Jl. Am. Inst. Elec. Engrs., vol 40, no. 9, Sept. 1921, pp. 730–736. Suggestions for improvement.

ELECTRIC DRIVE

Food Industry. Electrical Service Aids a Leading Western Food Industry. Jl. Elec. & Western Ind., vol. 47, no. 4, August 15, 1921, pp. 146–147, 5 figs. Shows that introduction of electric driving has improved operating conditions and lowered production costs.

Machine Tools. Electric Motor Drive for Machine Tools, Gordon Fox. Ry. Elec. Engr., vol. 12, no. 8, August 1921, pp. 317–321, 5 figs. Discusses relative advantages of different types of motors.

ELECTRIC FURNACES

Ajax-Wyatt. The Ajax-Wyatt Electric Furnace, John B. C. Kershaw. Engineer, vol. 132, no. 3423, Aug. 5, 1921, pp. 139–140, 4 figs. Details of improved type. For special work of melting yellow brass, on scale which permits continuous operation of furnace, it is said to be most efficient type.

Design. Electric Furnace Operating Experiences, Larry J. Barton. Iron Age, vol. 108, no. 10, Sept. 8, 1921, pp. 581–584, 6 figs. Experiments with three forms of furnace bottom. Methods of building bottoms. Experiments with roof and sidewalls. Metallurgical features.

Non-Ferrous. Melting Steel in a Non-Ferrous Electric Furnace. Iron Age, vol. 108, no. 8, Aug. 25, 1921, p. 472, 1 fig. Successful production of crucible quality steel in small Baily resistance unit.

Tagliaferri. New Italian Electric Furnace (Nuovo forno electrico italiano), Mario Marantonio. Il Forno Electrico, vol. 3, no. 4, April 15, 1921, pp. 41–50, 14 figs. Describes Tagliaferri furnace recently installed at Grandi Acciaiere e Fonderie Gio. Ansaldo.

ELECTRIC LOCOMOTIVES

Development. Possibilities in the Development of Electric Locomotives (Entwicklungsmöglichkeiten der elektrischen Vollbahnlokomotive), Egon E. Seefehlner. Schwerzerische Bauzeitung, vol. 78, nos. 2 and 3, July 9 and 16, 1921, pp. 15–18 and 30–33, 16 figs. Points out advantages and disadvantages of the three types in common use, namely, direct-drive, geared, and underslung motor geared. Discusses possibility of developing a type combining advantages of all three types with elimination of their defects.

Oerlikon. New Single-Phase Locomotives of the Swiss Railways (Les Nouvelles Locomotives Monophasées des Chemins de Fer Féderaus), Lucien Pahin. L'Industrie Electrique, vol. 30, no. 699, August 10, 1921, pp. 285–290, 7 figs. Describes the 2-6+6-2 Oerlikon type of Gothard line, its mechanical and electrical equipment.

Parallel-Crank Drive. Vibratory Phenomena of the Parallel-Crank Drive of Electric Locomotives (Ueber Schüttelerscheinungen des Parallelkurbelgetriebes elektrischer Lokomotiven), Iwan Döry. Schweizerische Bauzeitung, vol. 78, no. 6, Aug. 6, 1921, pp. 63–66, 4 figs. Supplementary remarks to author's article published in Elektrotechnische Zeit. (vol. 41, Apr. 22, 1920, p. 313) in reply to criticisms of work by A. Wichert.

Standardization. The Serialization of Electric Locomotives as a Basis for Their Standardization (Ueber Reihenbildung elektrischer Lokomotiven als Voraussetzung für ihre Vereinheitlichung), A. Wichert. Annalen für Gewerbe u. Bauwesen, vol. 88, nos. 11 and 12, June 1 and 15, 1921, pp. 93–98 and 105–113, 8 figs. It is shown that with proper reduction of frictional weight of a.c. trunk-line locomotives according to a geometrical series with increase of $\sqrt{2}$ and the same reduction of maximum speeds, outputs of from 45 to 127 km. per hr. max. speed and with 2 to six driving axles can be obtained from only 3 motor and 2 transformer basic types for all 14 types of locomotives used in Germany.

Steam vs. Mechanical Advantages of Electric Locomotives Compared With Steam Engines, V. L. R. Raven. Elec. Rev. (Lond.), vol. 89, no. 2280, August 5, 1921, pp. 194 and (discussion) pp. 194–195. (Abstract.) Paper read before Eng. Conference, 1921.

Transmissions. A New Power Transmission System Between Motors and Axles of Electric Locomotives (Norveau Systeme de Transmission de Mouvement entre les Moteurs et les Essieux des Locomotives Electriques), M. Auvert. Révue Générale des Chemins de Fer et des Tramways, vol. 40, no. 8, August 1921, pp. 88–96, 6 figs. Describes system based on connecting rods in which vibrations of locomotive have no deleterious effect.

ELECTRIC MACHINERY

Balancing. Balance of High-Speed Electric Dynamos and Motors, H. D. Wheeler. Electrician, vol. 87, no. 2254, July 29, 1921, pp. 136–138, 9 figs. Indicates briefly some of the main causes of vibration in turbo-generators and similar machines and how to overcome it.

ELECTRIC MOTORS

Overload Protection. Overload Protection of Motors Edgar P. Slack. Power, vol. 54, no. 4, July 26, 1921, pp. 132–133. Use of fuses, circuit breakers and motor starters.

ELECTRIC RAILWAYS

Starting System. New Starting System for Traction by Continuous Current; Inductive Starters (Nouveau Système de Démarrage pour la Traction par Courant Continu: Les Démarreus Inductifs), Armand Givelet. Révue Générale de L'Electricité, vol. 10, no. 4, July 23, 1921, pp. 133–137, 6 figs. Describes new, simple method for which considerable saving in current is claimed.

Three-Wire Distribution. Three-Wire Railway Distribution in Wilmington, A. P. Way. Elec. Ry. Jl., vol. 58, no. 9, August 27, 1921, pp. 307–311, 5 figs. Improves regulation and prevents electrolysis. Trial proves system best adapted to radial city districts.

Trolley Systems. Electric Overhead Line Systems (Note su les lignes caténaires pour prise de courant aérienne destinées à l'électrification des voies d'intérêt général). Paul Leboucher. Révue Générale de l'Électricite, vol. 10, no. 6, August 6, 1921, pp. 195–201, 16 figs. Discusses pantograph trolley and feeding of current. (To be continued.)

ELECTRIC WELDING

Methods. Electric Welding Apparatus (Les Machines a Souder), Ch. Andry-Bourgeois. L'Electricien, vol. 52, no. 1282, August 15, 1921, pp. 361–367, 8 figs. Discusses various methods of electric welding and uses made of them. (To be continued.)

ELECTRIC WELDING, ARC

Electric-Railway Work. Electric Arc Welding, Henry M. Sayers. Elec. Ry. & Tramway Jl., vol. 45, no. 1091, August 12, 1921, pp. 129–132 and (discussion) pp. 132–133, 7 figs. Deals with failures, welding of lattice masts, covered and bare electrodes, etc. Paper read before Tramways & Light Rys. Assn

Fillet and Butt Welding. Fillet and Butt Welding by the Electric Arc. Can. Machy., vol. 26, no. 6, August 11, 1921, pp. 33–34 and 53, 2 figs. Discusses welds by spreading, butt welding, double "V" weld.

Machines. A New Electric Arc Welding Machine. Engineer, vol. 132, no. 3418, July 1, 1921, pp. 18–19, 5 figs. Details and working of new machine known as cyc arc, because of regular cycle of operations on which its success depends and which it accurately performs.

ELECTRIC WELDING, RESISTANCE

Spot-Welding Machines. Spot-Welding Machines (Machine a Souder par Points), P. Saurel. Arts et Métiers, vol. 74, no. 9, June 1921, pp. 173–177, 13 figs. Describes principle, apparatus and operation.

Spot Welding Machine for Making Ships' Ventilators. Engineer, vol. 132, no. 3424, Aug. 12, 1921, p. 176, 1 fig. New type of electric machine for manufacture of large ventilating cowls for steamships, and other bulky hollow sheet-metal articles of similar nature.

ELEVATORS

Safety Devices. Electric Elevator Machinery—Car Safeties, M. A. Myers. Power, vol. 54, no. 5, Aug. 2, 1921, pp. 176–177, 6 figs. Describes heavy-duty double-eccentric, compression-type and flexible guide-clamp type safety.

EMBOSSING

Dies. Making Embossing Dies for Emblematic Work, Chas. E. Hall. Can. Mach., vol. 26, no. 7, August 18, 1921, pp. 36–38, 5 figs. Discusses hub method, "cut in" system, and their combination.

EMPLOYEES, TRAINING OF

Economic Advantages. Training as a Factor in Reducing Labor Cost, J. F. Johnson. Management Eng., vol. 1, no. 1, July 1921, pp. 5–9, 5 figs. How instructing the worker enhances his skill, increases production and lowers manufacturing costs.

Training as a Factor in Reducing Waste, J. F. Johnson. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 93–97, 6 figs. How teaching of correct working habits will develop skill, reduce labor turnover and save material.

EMPLOYMENT MANAGEMENT

Personnel, Selection and Placement of. The Personnel Problem: To Eliminate the Waste of Human Effort, L. B. Hopkins. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 385–388. States that many wastes of time and production can be attributed to improper selection and placement of personnel and to management's failure to recognize value of training, transfer and promotion of deserving employees.

Present Need of. Is Personnel Management Essential Now? Earl B. Morgan. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 89–92. Points out that pressing labor problems must be solved in periods of force reductions as well as in times of shortage of workers.

ENGINEERING LITERATURE

Classification and Indexing. Classifying and Indexing the Clipping File, Harrison W. Craver, Management Eng., vol. 1 no. 1, July 1921, pp. 49–50.

Applying use of decimal classification system to engineering literature. Adoption by Engineering Societies library. Plan of Management Engineering.

ENGINEERS

Problems Confronting. The Pioneer Spirit in Engineering, E. S. Carman. Management Eng., vol. 1, no. 1, July 1921, pp. 1–3. As developed in Federated Am. Eng. Societies. Notes on engineers' problem of future; two major influences in engineering elimination of waste in industry.

EXPANSION

Thermal. The Thermal Expansion of Certain Materials (Ueber die Wärmeausdehnung einiger Stoffe), Karl Scheel. Deutsche Optische Wochenschrift, vol. 7, no. 31, July 31, 1921, pp. 562–563. Results of experiments carried out in German National Physical-Technical Inst. with different materials according to the Fizeau and the so-called tube method.

F

FACTORIES

Design. The Design and Construction of Engineering Workshops—XXI, Ernest G. Beck. Mech. Wld., vol. 52, no. 1806, August 12, 1921, pp. 122–123, 5 figs. Continues discussion of construction of roofs. (To be continued.)

Location. Location as a Factor in Eliminating Industrial Waste, Victor V. Kelsey. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 401–402. Main factors to be considered are: Influence which proposed industry will have on community, raw materials, transportation, labor supply and power.

The Scientific Location of Manufacturing Plants, J. George Frederick. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 153–155, 1 fig. Deals with considerations that govern proper location of manufacturing plant and conditions arising due to shift of population or manufacturing centers.

Layout. Developing an Industrial Plant Layout, A. T. Doud. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 149–152, 4 figs. Points out that in complete design of new plant, it is necessary to work out together the general production system, department layout and general features of building construction in order to insure well-balanced plant.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FATIGUE

Testing. Improvements in Methods of Fatigue Testing, H. J. Gough. Engineer, vol. 132, no. 3424, Aug. 12, 1921, pp. 159–162, 13 figs. Report submitted to materials and chemistry committee of Aeronautical Research Committee. Experiments on alternating torsion; forms of test pieces; strain measurements; method of test using strain and calorimetric methods simultaneously, etc.

FIRE HAZARDS

Review of. Some Considerations on Fire Waste, Nicholas Richardson. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 397–400. Industry in general, and chemical industry in particular, is said to be in need of fuller appreciation of fire hazards and appalling waste due to destruction by fire. Review of possible fire hazards.

FIRE PROTECTION

Slow-Burning Buildings. Specifications for "Slow Burning" Office Buildings, Ira H. Woolson. Eng. & Contracting, vol. 56, no. 8, Aug. 24, 1921, pp. 178–179. Report submitted by committee on building construction of Nat. Fire Protection Assn. containing proposed specifications for rendering so-called non-fireproof class of commercial buildings reasonably slow-burning.

FIREPROOFING

Cotton Fabric. The Effect of Certain Fire-Proofing Solutions on Cotton Fabric, R. L. Sibley. Jl. Ind. & Eng. Chem., vol. 13, no. 8, August 1921, pp. 676–677, shows that sodium, tungstate has the least weakening action and recommends it as an excellent fireproofing agent.

FLIGHT

Soaring. Mechanical Models for Soaring Flight (Mechanische Modelle zum Segelflug), Th. v. Karman. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 14, July 30, 1921, pp. 220–223, 4 figs. Simple mechanical devices for study of energy and speed conditions in connection with soaring flight.

Soaring (Bemerkungen über den Segelflug), L. Prandtl. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 14, July 30, 1921, pp. 209–211. Discusses possibilities of soaring; sources and utilization of energy in soaring flight of birds and men. Conditions for minimum descending speed are investigated and numerical example given.

FLOW OF WATER

Chézy Formula. Antoine Chezy. History of an Hydraulic Formula (Antoine Chezy. Histoire d'une Formule d'Hydraulique), G. Mouret. Annales des Ponts et Chaussees, vol. 59, no. 2, 11th Series, March-April 1921, pp. 165–268. His formula $U = C\sqrt{(RI)}$ for flow of water. Bibliography.

Gibson Method. Theoretical Discussion of the Hydrometric Method of N. R. Gibson (Theoretische Erörterungen zur Wassermessmethode von N. R. Gibson). Schweizerische Bauzeitung, vol. 78, no. 4, July 23, 1921, pp. 41–43. Refers to method described in Canadian Engineer (vol. 39, no. 12, Sept. 16, 1920), and points out that it is difficult to fulfill all the conditions required in application of method, which, in author's opinion, represents no progress in hydrometry.

Photographic Measurement. Use of Photography in Hydraulic Measurements in India, S. C. Majumdar Eng. News-Rec., vol. 87, no. 10, Sept. 8, 1921, pp. 414–415, 2 figs. Photographic tests made on large jets are said to check remarkably close with actual gagings by current meter.

Venturi Tubes. Nomograms for Calculating Flow in Venturi Tubes, J. W. Ledoux. Eng. & Contracting, vol. 56, no. 6, Aug. 10, 1921, pp. 138–139, 3 figs. Three nomograms are presented and their uses explained.

FLYING BOATS

Construction. Flying Boat Construction, David Nicolson. Aeronautical Jl., vol. 25, no. 128, August 1921, pp. 385–412 and (discussion) pp. 413–420, 16 figs. Gives details of construction of types F, P and N; concludes that in an aero-engine a high degree of compression is essential and that tests established the possibility of supercompression as a means of power recuperation at high altitude.

Leoning Model. The Leoning Model 23 Flying Yacht. Aviation, 11, no. 9, August 29, 1921, pp. 248–250, 5 figs. Gives data of machine and describes test recently made.

FOUNDRIES

Brass and Aluminum. Features of a Non-ferrous Metal Foundry, F. L. Prentiss. Iron Age, vol. 108, no. 9, Sept. 1, 1921, pp. 511–513, 3 figs. Outstanding features of new jobbing brass and aluminum foundry of National Bronz & Aluminum Foundry Co., Cleveland, Ohio.

Casting Costs. Promoting Economy in Iron Foundries by Means of Uniform Rules and Fundamental Principles for the Production and Evaluation of Castings (Die Erhöhung der Wirtschaftlichkeit un der Eisengiesserei durch einheitliche Leitsätze und Unterlagen für die Herstellung und Bewertung der Gusserzeugnisse), Joh. Mehrtens. Betrieb, vol. 3, no. 20, July 10, 1921, pp. 613–617, 2 figs. Includes report of work being done by expert committee for foundry products of German Industry Committee on Standards (N.D.I.), and points out importance of adopting standard terms and classifications, specially for cast-iron products.

Continuous. Continuous Foundry for Pipe Fittings, Henry M. Lane. Iron Age, vol. 108, no. 9, Sept. 1, 1921, pp. 519–524, 10 figs. Designed for minimum handling of sand, castings, cores, hot metal and flasks. Layout and details.

Electrical Equipment. Electrical Apparatus in the Foundry, F. D. Egan. Foundry, vol. 49, no. 16, August 15, 1921, pp. 646–651, 16 figs. Discusses cupola and air furnaces, transformers and motor equipment, also gives data on operation of foundries.

Mechanical Control. Mechanical Control in Foundry Problems, J. H. Hopp. Iron Age, vol. 108, no. 8, Aug. 25, 1921, pp. 456–458, 5 figs. Discusses several cases showing how application of simple mechanics produced results which chemistry alone did not. (Abstract.) Address delivered before Southern Metal Trades Assn.

FREIGHT HANDLING

Ashley Planes. Ashley Planes for Handling Freight Traffic, C. H. Stein. Min. & Metallurgy, no. 177, Sept. 1921, pp. 45–46. Notes on installation of hoisting engines of large capacity at head of each plane, which, by means of large cables, haul cars to objective point. (Abstract.) Paper read before Am. Inst. Min. & Metallurgical Engrs.

FRICTION

Rolling. Measuring Accelerations and Coefficients of Rolling Friction At the Metropolitan Railway of Paris (Mesures d'accélérations et de coëfficients de roulement au chemin de fer métropolitain de Paris), R. Van Cauwenberghe. Société Belge des Électriciens, vol. 35, May-June 1921, pp. 101–118, 9 figs. Describes level and electric accelerometers and tests made with former.

FUEL CONSERVATION

Power Plants. Elimination of Waste in Industrial Power Plants, David Moffat Myers. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 413–416. Shall an industry own its power plant or buy its power? Determining factor is relation of heating and process steam to power demand. The what and why of fuel economy.

Reducing Coal Consumption from 51 to 27 Tons a Day, H. A. Ward. Power, vol. 54, no. 5, Aug. 2, 1921, pp. 172–174, 4 figs. Describes changes made in steam-generating plant to effect this reduction.

FUELS

Anthracoal. Anthracoal: A New Domestic and Metallurgical Fuel, Donald Markle. Trans. Am. Inst. Min. & Met. Engrs., No. 1086-C, August 1921, 11 pp., 1 fig. Gives comparative results of tests of anthracoal and coke, analysis of anthracoal, process of manufacture and by-products obtained. (Also in Coal Age, vol. 20, no. 8, August 20, 1921, pp. 296–299.)

Bituminous Coal. Utilization Refinement of Fuels, F. P. Coffin. Gas Age-Rec., vol. 48, no. 5, August 20, 1921, pp. 176–178. Discusses processes for conversion of bituminous coal into primary fuel and power.

Recovery from Furnace Residue. The Schilde Process for the Treatment of Furnace Residue (Das Schildesche Aufbereitungsverfahren für Feuerungsrückstände), A. Pradel. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 10, Mar. 11, 1921, pp. 73–74, 2 figs. Details of the Kolumbus separator.

Utilization. Commission for Utilization of Fuel (Commission D'Utilisation du Combustible), Revue de L'Industrie Minérale, no. 14, July 15, 1921, p. 506. (Continuation of serial.)

[See also LIGNITE; PEAT.]

FURNACES, ANNEALING

Gas-Fired. Gas-Fired Annealing Furnace. Iron & Coal Trades Rev., vol. 103, no. 2786, July 22, 1921, pp. 107, 3 figs. Describes tests made with plant consisting of two self-contained twin-pot rotary flame annealing furnaces.

FURNACES, BOILER

Burning Mixed Fuels. The Burning of Fuel Mixtures (Verfeuerung verschiedenartiger Brennstoffe), Karl Schäfer. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 17, Apr. 29, 1921, pp. 130–133, 2 figs. Results of combustion tests carried out in 1915 in two-header water-tube boiler of the Berlin municipal gas works, in order to obtain desiderata for an expedient burning of coke and coke mixtures with other fuels. Abstracted from report of Soc. for Promotion of Moor Coal Cultivation.

French Types. Furnace Operation and Coal Conservation in France During the War (Feuerungsbetrieb und Kohlewirtschaft in Frankreich während des Krieges), A. Pradel. Feuerungstechnik, vol. 9, no. 21, Aug. 1, 1921, pp. 193–197, 16 figs. Notes on the Ratel underfeed furnaces; the Godillot furnaces for waste wood; the Serret grates for use of low-grade fuel; the Genevet forced-draft furnaces; the Prat induced-draft system; etc.

Nozzle Grate Bars. Progress in Forced-Draft Furnaces (Neues von Unterwindfeuerungen), A. Pradel. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 22, June 3, 1921, pp. 169–172, 9 figs. Describes nozzle grate bars constructed by Berlin-Anhalt Machine Constr. Corp., Dessau; Dr. Hans Cruse & Co., Berlin-Charlottenburg; and Thost, Zwickau.

FURNACES, INDUSTRIAL

Egler. Adapts Blow Torch Idea To Furnace, George L. Prentiss. Foundry, vol. 49, no. 16, August 15, 1921, pp. 639–640, 1 fig. Describes Egler patent applicable to all kinds of liquid gas and fuel and powdered coal.

Efficiency. The Efficiency of Industrial Furnaces, Hugh Chambers. Can. Machy. vol. 26, no. 7, August 18, 1921, pp. 33–35, 5 figs. Increase in efficiency due to modern design.

Gas and Oil. New Gas and Oil Furnaces (Neue Gas- und Oelfeuerungen), A. Pradel. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 5 and 6, Feb. 4 and 11, 1921, pp. 33–34 and 43–44, 20 figs. Details of recent German patents.

FURNACES, METALLURGICAL

Heat Losses. The Fundamental Principles of Heat Losses of Metallurgical Furnaces (Die Grundlagen der Wärmeverluste metallurgischer Oefen), P. Rosin. Metall u. Erz, vol. 17, no. 21, Nov. 8, 1920, pp. 463–475 and vol. 18, nos. 2, 4 and 5, Jan. 22, Feb. 22 and Mar. 8, 1921, pp. 37–45, 78–88 and 99–104, 14 figs. Nov. 8: The geometrical factor. Jan. 22: The material factor. Feb. 22: The external heat conductivity; the temperature factor. Mar. 8: The time factor.

G

GAGES

Inspection. The Delco Inspection System, Erik Oberg. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1127–1130, and vol. 28, no. 1, Sept. 1921, pp. 43–47, 23 figs. Typical Examples of gaging fixtures used by Dayton Engineering Laboratories Co. in manufacture and inspection of company's product.

Plug and Ring. The Selection of Gages for Cylindrical Allowances (Auswahl der Lehrenarten für Rundpassungen), K. Gottwein. Werkstattstechnik, vol. 15, no. 13, July 1, 1921, pp. 393–400, 20 figs. Suggestions for an economical selection of gages from the two allowance systems in present use.

GAS PRODUCERS

Development. Developments in the Construction of Gas Producers (Die Entwicklung des Gaserzeugerbaues), H. R. Trenkler. Glasers Annalen für Gewerbe u. Bauwesen, vol. 89, no. 1, July 1, 1921, pp. 3–8, 14 figs. Discusses various types. It is claimed that the revolving-grate producer has replaced all older types.

Operation. Gas-Producer Practice, N. R. Rees. Mech. Wld., vol. 70, no. 1804, July 29, 1921, pp. 89–90. Discusses essential features, even distribution of coal, uniform production of good-quality gas, regulation of depth of fuel bed, removal of ashes and clinker, and low cost of operating.

GEAR CUTTING

Stevenson Multiple Shaper. The Stevenson Multiple Shaper. Machinery (Lond.), vol. 18, no. 463, August 11, 1921, pp. 578–581, 8 figs. A new type of gear-cutting machine.

The Stevenson Gear Wheel Shaping Machine. Engineer, vol. 132, no. 3422, July 29, 1921, p. 128, 2 figs. Details of multiple shaping machine for cutting gear wheels, which cuts all or large proportion of teeth simultaneously.

GEARS

Fabroil. Fabroil and Textoil—Textile Fibre Products that Give Good Service In Gears, G. L. Wilder. Raw Material, vol. 4, no. 8, August 1921, pp. 279–280, 1 fig. Discusses fabroil gears and textoil gears.

Grinding. Grinding Gear Wheel Teeth. Engineer, vol. 132, no. 3422, July 29, 1921, pp. 112–113, 2 figs. Describes specialist work of grinding of tooth profiles to a stated standard of accuracy performed by Gear Grinding Co., Ltd., Birmingham.

Gear Tooth Grinding. Machinery, (Lond.), vol. 18, no. 462, August 4, 1921, pp. 542–545, 8 figs. Describes system of Gear Grinding Co., Ltd.

Involute. Inspection of Involute Spur and Helical Gear Hobs—I, Carl G. Olson. Machy. (N. Y.), vol. 28, no. 1, Sept. 1921, pp. 11–13, 12 figs. Testing accuracy of hob and tooth parts; hobbing tests.

The Evolution of the Involute Gear Tooth—VII and VIII, A. Fisher. Machinery (Lond.), vol. 18, nos. 461 and 462, July 28 and Aug. 4, 1921, pp. 507–510, 4 figs., and 547–551, 14 figs. Discusses conditions of contact, lengths of contact paths and numbers of teeth.

Maag. Principles of Maag Gearing. Machy. (N. Y.), vol. 28, no. 1, Sept. 1, 1921, pp. 48–52, 9 figs. Analysis of Maag system of gearing, advantages claimed for this type of gears, and machines for their production.

Rolling-Mill Driving. Cutting Rolling Mill Driving Gears, Fred R. Daniels. Machy. (N. Y.), vol. 28, no. 1, Sept. 1921, pp. 1–4, 5 figs. Producing large herringbone gears by end-milling process at Woodard Machine Co.'s plant in Wooster, Ohio.

GIRDERS

Reinforced-Concrete. Construction Joints in Concrete Girders of 62½ Ft. Span. Eng. News-Rec., vol. 87, no. 9, Sept. 1921, pp. 348–350, 4 figs. Unique design is said to safeguard reinforced-concrete garage under Williamsburg bridge against cracking in event of uneven pier settlement.

GLASS MANUFACTURE

Sheet, Drawing. The Drawing of Sheet Glass. Glass Ind., vol. 2, no. 8, August 1921, pp. 190–193, 3 figs. Describes invention of Emile Gobbe developed by Emile Fourcault, and results obtained leaving no doubt as to ultimate success of process. (Abstract, Le Verre.)

GRAIN ELEVATORS

Floating Pneumatic. The Floating Pneumatic Grain Elevator at Avonmouth Dock, George F. Zimmer. Eng. & Indus. Management, vol. 6, no. 8, Aug. 25, 1921, pp. 221–225, 4 figs. Details of pneumatic plant known as the Alpha, which is mounted on pontoon of reinforced concrete divided by concrete bulkheads into separate compartments for accommodation of boiler, engine, elevators, and crew.

GRAIN HANDLING

Pneumatic Plant. Pneumatic Grain-Discharging and Sack-Handling Plant at Bordeaux. Engineering, vol. 112, no. 2904, Aug. 26, 1921, pp. 312–314, 19 figs., partly on p. 316 and supp. plate. Two traveling pneumatic grain-discharging installations, delivering on to elevated belt conveyors running length of wharf; these conveyors deliver in turn to others running at right angles to them, back to silos of 7500 tons capacity, whence grain may be stacked off and stored in warehouses. (To be continued.)

GRINDING

Automobile Parts. Grinding in the Automotive Industry—II, P. M. Heldt. Automotive Ind., vol. 45, no. 7, August 18, 1921, pp. 315–317, 3 figs. Development of specialized forms of grinding. (To be continued.)

Fixtures. Grinding Practice—Variety of Fixtures Used, F. Scriber. Can. Machy., vol. 26, no. 6, August 11, 1921, pp. 28–31, 14 figs. Discusses principles and shows how grinding wheel comes into contact with work.

Some Novel Grinding Fixtures, Andrew Macnab. Am. Mach., vol. 55, no. 8, Aug. 25, 1921, pp. 309–312, 9 figs. Grinding blocks with ends parallel. A fixture that failed and how trouble was remedied.

GRINDING MACHINES

Manufacture. Building Grinding Machines. Eng. Production, vol. 3, no. 45, August 11, 1921, pp. 133–139, 19 figs. Description of products of Churchill Machine Tool Co., Ltd., Manchester, Eng.

H

HANDLING MATERIALS

Automobile Plant. Handling Materials in an Automobile Plant, Fred H. Colvin. Am. Mach., vol. 55, no. 8, Aug. 25, 1921, pp. 292–296, 12 figs. Utilizing elevators and floors openings for carrying material from one floor to next. Continuous assembly and modern devices for facilitating work.

Methods. Moving Parts from Operation to Operation, J. M. Macrae. Management Eng., vol. 1, no. 3, Sept. 1921, pp. 167–169, 4 figs. Discusses four methods: Moving by trucks, rolling down chutes, sliding on gravity conveyors, handling by power conveyors.

HARDNESS

Testing. Hardness Testing (Beitrag zur Härteprüfung), F. Waizenegger. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 31, July 30, 1921, pp. 824–827, 5 figs. Describes method making use of ball test and exemplifies its practicability.

HEALTH

Chemical Industry. Occupational Diseases in Chemical Industries, Frederic Dannerth. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 145–147, 4 figs. How workers in chemical plants are safeguarded.

Industrial. Human Waste in Industry, Harry E. Mock. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 369–374, 2 figs. Strong emphasis is placed on role of physician in industrial plants, with outline of preventive and curative medical services which can be rendered to working forces in industry.

HEAT

Conservation. Premiums for the Saving of Heat (Ersparnisprämien in der Wärmewirtschaft), Friedrich Münzinger. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 1 and 2, Jan. 7 and 14, 1921, pp. 1–3 and 9–12, 3 figs. Means and methods of calculating utilization of heat in boiler room, and instruments required for measuring consumption of coal, feedwater and condensation quantities of large turbines, amount of electric energy produced, etc. Curves showing performance of boiler system of the Golpa power station, Germany.

HEAT TRANSMISSION

Liquid to Liquid. Law of Heat Transmission Between Liquids in Heat Exchangers (Lois numériques de la Transmission de la Chaleur entre les fluides dans les Echangeurs industriels) H. Dieterlen. Chaleur et Industrie, vol. 2, no. 15, July 1921, pp. 406–409, 1 fig. Mathematical discussion of speed of transmission, review of previous work on this subject. (To be continued.)

Pipe Lines. Investigations of Heat Transmission in Pipe Lines (Die bisherigen Untersuchungen des Wärmeüberganges in Rohrleitungen mit besonderer Berücksichtigung der Forschungen von Professor Nusselt), H. Schmolke. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 11, Mar. 18, 1921, pp. 81–84. Special consideration of research work of Professor Nusselt.

HEATING

Gas and Electric. Gas and Electric Heating (Chauffage au gaz et chauffage à l'électricité), A. Grebel. Chaleur et Industrie, vol. 2, no. 15, July 1921, pp. 426–432. Comparative analysis concerning domestic heating.

HEATING, ELECTRIC

Granular Metal. Using Granular Metal in Electric Heating (Sur l'emploi des métaux granulaires pour le chauffage électrique), Oct. Dony-Hénault. Académie Royale de Belgique—Mémoires, vol. 6, March 1921, 57 pp., 15 figs. Discusses granular resistances; comparison of carbon resistances with granular metal ones; electric properties of granular metallic masses; granular conductivity; melting point of granular metal etc. in connection with electric furnaces.

HEATING, HOT-WATER

Pipe Resistance. Calculation of the Resistance in Piping for Hot-Water Heating (Die Widerstandsberechnung der Rohrleitungen von Warmwasserheizungen), Otto Ginsber. Gesundheits-Ingenieur, vol. 44, nos. 24 and 28, June 11 and July 9, 1921, pp. 281–293 and 345–350, 9 figs. Tables giving friction values obtained from the Brabbée and other calculating methods. The Brabbée tests are said to prove that small errors in construction of pipe lines can have great influence on result, the magnitude of which however, has not yet been determined; hence the Brabbée investigations do not represent final solution of problem. Writer claims that it is possible, by deviating from theoretical accuracy, to simplify calculations, thereby effecting a great saving in time and in cost of installation, without risk of building inferior or too costly installations.

HEATING, STEAM

Methods. Methods and Basic Principles of Heating with Steam (Arten und rechnerische Grundlagen der Erhitzung mit Dampf), Rudolf Kaesbohrer. Chemiker-Zeitung, vol. 45, no. 9, Jan. 20, 1921, pp. 69–73, 1 fig. Includes table showing relations between pressure, temperature and heat content of saturated steam. Notes on direct and indirect steam heating; heating of air or gas.

HOUSING

Dense Tenement Populations, Eliminating. Population Density as a Basis for Housing Regulations, Frank B. Cartwright. Eng. News-Rec., vol. 87, no. 8, Aug. 25, 1921, pp. 318–322, 3 figs. Intensive Rochester study indicates that improved transit, industrial decentralization, zoning and other current changes render dense tenement populations unnecessary in most cities.

Traffic and. Traffic and Housing in Large Cities, Arthur Ertel. Elec. Ry. Jl., vol. 58, no. 6, August 6, 1921, pp. 199–201, 5 figs. Finds that there exists a definite relation between track and building development within different areas equidistant from a city center. (Abstract from Verkehrstechnik.)

HYDRAULIC PRESSES

Single-Acting. Pressing Stator Plates into Motor Casings, and Rotor Plates on Squirrel Cage Rotors on a Single-Acting Hydraulic Press, J. Blakey and J. Shankley. Eng. & Indus. Management, vol. 6, no. 4, July 28, 1921, pp. 86–87, 13 figs. Equipment designed for use in connection with single-acting hydraulic press.

HYDRAULIC TURBINES

Draft Tubes. Hydro-Electric Practice—Draft Tubes, C. Voetsch. Power, vol. 54, no. 5, Aug. 2, 1921, pp. 164–167, 10 figs. Discussion and comparison of various types of draft tubes.

High-Head Reaction. Important Features in the Design of High-Head Reaction Turbines, F. H. Rogers. Power, vol. 54, no. 7, Aug. 16, 1921, pp. 244–248, 9 figs. A 30,000-hp. unit for Big Creek, no. 8 development of Southern California Edison Co. Leakage at runner seals and around guide vanes. Draft tube, casing and relief-valve design. Lubricating of internal parts. Governor control.

Kaplan. The Economic Utilization of Water Energy by Means of the Kaplan Turbine (Die wirschaftliche Ausnutzung der Wasserenergie durch die Kaplan-Turbine), H. Donath. Elektrotechnischer Anzeiger, vol. 38, nos. 95, 96 and 97, June 16, 18 and 21, 1921, pp. 641–644, 649–650 and 659–660, 23 figs. Details and advantages of the Kaplan turbines.

Norway. The Turbines of the Vammua Hydroelectric Works, Norway (Vamma kraftanlægs turbiner), Ch. Woxholt. Teknisk Ukeblad, vol. 68, no. 18, May 6, 1921, pp. 209–212, 8 figs. Deals especially with sixth turbine which differs from older ones. With 214 r.p.m. and 27 m. head, it has output of 14,330 hp.; maximum diameter of casing is 5.7 m. Account of trial run.

Wear. Wear of Hydraulic Turbines (L'Usure des Turbines Hydrauliques)—IV, Henri Dufour. La Houille Blanche, vol. 20, no. 53–54, May-June 1921, pp. 97–104, 13 figs. Description of sand removers used at Ackersand Works.

HYDRAULICS

Eddy Flow. Eddy Flow and Hydrodynamical Conceptions in Connection Therewith (Wirbel und im Zusammenhang damit stehende Begriffe der Hydrodynamik), A. Betz. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 13, July 15, 1921, pp. 193–198, 19 figs. Based on typical examples, conception of rotation in two-directional motion of liquid is discussed and it is shown that through the pure forces of pressure without friction no rotational motion can be produced. In general, frictional forces are only noticeable in vicinity of solid walls. Discusses law stating that circulation along eddy is constant. Examples of the most frequently occurring forms of eddy.

Recent Progress. New Results in Hydromechanics (Neue Ergebnisse der Hydromechanik), H. v. Sanden. Glückauf, vol. 57, no. 27, July 2, 1921, pp. 629–636, 12 figs. Review of progress in recent years. Notes on Newton's theory on resistance of bodies in agitated liquid; the Euler streamline theory of frictionless liquid; friction of liquids; limit-stream theory of Prandtl; resistance formula, the Reynolds coefficient.

Theory. Contribution to the Theory of Hydraulic Motion (Nuovo Contributo alla Teoria dei Moti Idraulici), P. Alibrandi. Il Nuovo Cimento, vol. 22, Series 6, July-August 1921, pp. 94–113. Navier's hydrodynamic equations are valid for instantaneous velocity and pressure, but not for "hydraulic" velocity and pressure, which author develops mathematically.

HYDROELECTRIC PLANTS

Spain. Hydroelectric Plants of Guadiaro River, Spain (Les usines hydro-électriques du Guadiaro), Adolphe Weber. Schweizerische Bauzeitung, vol. 77, no. 26, June 25, 1921, pp. 299–301, 12 figs. (Concluded.)

Waterwheel Design and Setting. Advances in the Art of Waterwheel Designs and Settings, W. M. White. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 8, Aug. 1921, pp. 668–682, 23 figs. Notes on speed regulation; runners and runner materials; draft tubes; shaft and bearings; guide vanes; governors; turbine casing; vertical vs. horizontal units; control valves; and power house setting.

I

IGNITION

Adjustments. Different Ignition Adjustments and Their Effect on Performance of Engine and Consumption of Fuel (Verschiedene Zündeinstellungen und ihre Wirkung in bezug auf die Motorleistung und den Kraftstoffverbrauch), C. Wirsum. Motorwagen, vol. 24, no. 16, June 10, 1921, pp. 323–327, 21 figs. Discusses various adjustments of spark plugs, and gives chart showing output curves and fuel consumption with different ignitions.

INDUSTRIAL MANAGEMENT

Administrative Planning. Planning Applied to Administration. Eng. & Indus. Management, vol. 6, no. 7, Aug. 18, 1921, pp. 174–177. Indicates to what extent field of industrial administration has been entered by scientific management. Notes on planning of sales, relationship between stock and finished products, and finances.

Budgets and Production. The Expense and Finance Budgets, Park Mathewson. Indus. Management, vol. 62, no. 2, Aug. 1, 1921, pp. 109–113, 3 figs. How they concern production.

Charts. Managing an Industry by Graphic Charts, Arthur T. Burnet. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 83–87, 2 figs. Typical charts and their use. How current facts are quickly and economically supplied to executive.

Standardizing the "Z" Chart, Arthur R. Burnet. Management Eng., vol. 1, no. 3, Sept. 1921, pp. 153–158, 4 figs. Discusses standardizing type of management engineering chart known as the "Z" chart to permit of its production in quantity.

The Ratio Chart and Its Application—II and III, Percy A. Bivins. Indus. Management, vol. 62, nos. 2 and 3, Aug. 1 and Sept. 1, 1921, pp. 99–104 and 166–171, 19 figs. Based on memo notes of an office manual for guidance of draftsmen unfamiliar with ratio plotting. Advantages and disadvantages of ratio charts compared with charts on arithmetic basis.

[See also GANTT CHARTS.]

Efficiency. The Final Measure of Industrial Efficiency, A. L. DeLeeuw. Management Eng., vol. 1, no. 3, Sept. 1921, pp. 141–146, 1 fig. Notes on how to obtain maximum efficiency. Consideration of equipment and plant efficiency. Influence of capital charges. An application of index numbers.

Engineering Students, Training in. Existing Courses in Management Engineering, Collins P. Bliss. Management Eng., vol. 1, no. 1, July 1921, pp. 43–48, 1 fig. Gives make-up of eight courses and time allotted to each general group of subjects and to each study. Summary and chart showing number of hours devoted to individual subjects.

Gantt Charts. The Gantt Chart, Wallace Clark. Management Eng., vol. 1, nos. 2 and 3, Aug. and Sept., 1921, pp. 77–82, 9 figs., and 161–166, 6 figs. Advantages, principle, technique and application to man records and layouts.

Inspection. Inspection. Mech. Wld., vol. 52, 1806, August 12, 1921, pp. 118–119, 5 figs. Discusses necessity for inspection and the tact required by an inspector.

Marketing. The Elimination of Waste in Marketing, William R. Basset. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 420–422. States that marketing from point of view of manufacturer can be made more profitable by application of better methods of distribution and by establishment of improved selling policies.

Material Specifications. Material Specifications, E. A. Allcut. Eng. & Ind. Management, vol. 6, no. 5, August 4, 1921, pp. 114–115. Emphasizes necessity for complete specifications of materials in case of small users.

Overtime, Influence of. The Influence of Overtime on Costs, B. C. Sloat. Management Eng., vol. 1, no. 1, July 1921, pp. 9–10. Wage costs and shop maintenance as influenced by overtime; effect on shop morale and on workmanship.

Planning. Precalculation in the Factory (Aufgaben einer Betriebsvorkalkulation), Paul Bischoff. Werkstattstechnik, vol. 15, no. 15, Aug. 1, 1921, pp. 448–450, 5 figs. Points out advantages of predetermination of time required for finishing a workpiece.

Production Control. Production Control. P. J. Darlington. Indus. Management, vol. 62, no. 2, Aug. 1, 1921, pp. 95–98, 2 figs. Its strong and weak points. Author sets forth purposes and requirements and emphasizes permanent management's vital relationship to system.

Production, Economics of. The Economics of Production—III, D. A. McCabe. Am. Mach., vol. 55, no. 10, Sept. 8, 1921, pp. 381–382. Costs and price and production.

Production Increase. Accumulative Skill As a Factor in Production, Hugo Diemer. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 111–112. Proof that group experience and pride in work increase output.

Scientific Management—XXIX, Henry Atkinson. Eng. & Indus. Management, vol. 6, no. 4, July 28, 1921, pp. 97–98. Incentives to economical production.

Six Ways of Increasing Production, G. D. Halsey. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 97–98. (1) Introduction of labor-saving machinery; (2) specialization; (3) aggregation (combination with any other department); (4) standardization of parts; (5) elimination of wastes of materials; and (6) increasing individual efficiency.

Program for. What is Management in Industry? C. E. Knoeppel. Management Eng., vol. 1, no. 1, July 1921, pp. 23–28, 1 fig. Placing blame and fixing responsibility. A program for management.

Routing. Cutting Out Waste in the Shop. Elec. Ry. Jl., vol. 58, no. 6, August 6, 1921, pp. 193–198, 24 figs. Discusses minimizing of lifting operations, effective routing of machine jobs and permanent repair of defective parts.

The Group System of Process Planning, W. J. Hiscox. Machinery, (Lond.), vol. 18, no. 464, August 18, 1921, pp. 600–601. Discusses routing of jobs through the shop.

Small Factories. Management Problems of the Small Factory, Ernest Cordeal. Indus. Management, vol. 62, nos. 2 and 3, Aug. 1 and Sept. 1, 1921, pp. 114–119 and 182–187, 4 figs. Aug.: Costs and their use. Sept.: Supervision and inspection.

Storeskeeping. The Essentials of Storeskeeping, Wallace Clark and C. E. Davies. Management Eng., vol. 1, no. 1, July 1921, pp. 11–16, 9 figs. Notes on storeskeeper's responsibilities; marking the order points; keeping records of stock; safeguarding stores; disposing of unneeded material; and selection and training of personnel.

Production and the Stores Department, H. G. Harley. Eng. Production, vol. 3, no. 46, Aug. 18, 1921, pp. 150–154, 12 figs. Describes combined production and stock-recording system.

Woodworking Shops. Production Control in Wood-Working Shops, F. B. Sampson. Wood-Worker, vol. 40, no. 6, August 1921, pp. 30–32, 8 figs. Outline of fundamentals of production control. Gives time allowance and operations layout charts.

[See also FATIGUE; TIME STUDY.]

INDUSTRIAL ORGANIZATION

Large Contract Plants. Organization of Large Contract Plants, George H. Shepard. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1100–1103, 3 figs. Deals with organization of plants making variety of products, and establishment of planning, dispatching, and recording systems.

Small Shops. Organization and Management of the Small Shop—IV, E. W. Leach. Am. Mach., vol. 55, no. 9, Sept. 1, 1921, pp. 338–341. Financing company; coöperating with investor; advantages and disadvantages of partnerships and corporations.

INDUSTRIAL RELATIONS.

Americanization. Industrial Americanization, Luther D. Burlingame. Machy. (N. Y.), vol. 28, no. 1, Sept. 1921, pp. 30–32. Policy of Brown & Sharpe Mfg. Co. in assisting alien employees to become American citizens.

Human Elements in. Human Elements in Engineering, J. J. Flather. Bul. Minn. Federation Architectural & Eng. Societies, vol. 6, no. 7, July 1921, pp. 21–32. Discusses hours of work, pleasant surroundings, etc. and their influence on production. Lays stress on the point that philanthropy has no part in industrial management.

INDUSTRIAL TRUCKS

Lifting. The Edgar Brandt Elevator-Truck (Le Chariot élévateur Edgar Brandt), M. d'About. La Vie Automobile, vol. 17, no. 735, August 10, 1921, pp. 285–286, 2 figs. Description of hand-operated truck for loading and unloading boxes up to 400 kg. into and from delivery wagons.

INDUSTRY

Arbitration Courts. Wastes in Litigation, Wellington Gustin. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 423–427. Losses arising from litigation said to be potential factor in success or failure of any industry or business. Lack of knowledge of technical terms and standards on part of courts a strong argument for establishment of arbitration courts within industry.

INTERNAL-COMBUSTION ENGINES

Adapting to Rarefied Atmospheres. Adapting Explosion Engines to Rarefied Atmospheres (Le Problème de l'Adaptation des Moteurs a Explosions aux Atmosphères Raréfiées). L'Aeronautique, vol. 1, no. 9, February 1920, pp. 399–402, 6 figs. Reduces all methods to form fundamental ones and discusses these.

Cycle Evaluating Chart. A Nomographic Chart for Gases, T. B. Morley. Engineering, vol. 112, no. 2904, Aug. 26, 1921, pp. 302–304, 5 figs. Chart developed by author for evaluating with ease and rapidity internal-combustion-engine cycles, which yields approximate results, claimed to be preferable to "air standard" values.

Exhaust-Gas Analysis. A Further Application of Diagrams to the Analysis of Exhaust Gases (Eine weitere Anwendung von Schaubildern zur Abgasanalyse), K. Kutzner. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 33, Aug. 13, 1921, pp. 871–873, 1 fig. Chart is developed for simple determination of that part of carbon content of coal which is not consumed in combustion. Use of chart, employed by Neufeldt & Kuhnke, Kiel, for testing hot-bulb motors, is described with aid of examples.

Installation. Practical Notes on the Installation and Running of Petrol, Petrol-Paraffin, and Semi-Diesel Engines, D. P. Lamb. Mech. Wld., vol. 70, no. 1804, July 29, 1921, pp. 91–92. Discusses reverse gear, exhaust pipe, circulating pumps, gear pumps and fuel-supply system. (To be continued.)

Large-Cylinder. Internal Combustion Engines with Large Cylinders, James McKechnie. Gas & Oil Power, vol. 16, no. 191, August 4, 1921, pp. 173–174. Discusses requirements of mercantile ships, electric drive, two-stroke design, and gives table of test data of 1000-b.hp. single-cylinder engine. From paper read before Instn. Civil Engrs.

Operation. Practical Notes on the Installation and Running of Petrol, Petrol-Paraffin, and Semi-Diesel Engines, D. P. Lamb. Mech. Wld., vol. 52, no. 1805, August 5, 1921, pp. 112–115. Discusses carbureters, lubrication, magnetos, water circulation.

Vegetable Oils for. Vegetable Oils for Internal Combustion Engines, R. E. Mathot. Engineer, vol. 132, no. 3423, Aug. 5, 1921, pp. 138–139. Author gives results of his investigations and makes suggestions for improvements in design of engines to fill requirements of colonial service.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES.]

IRON

Foundry. Foundry Irons for Particular Uses, Y. A. Dyer. Iron Age, vol. 108, no. 10, Sept. 8, 1921, pp. 585–588. Differentiating characteristics of gray iron, mottled, chilled or white. Analyses of certain castings.

IRON ALLOYS

Iron-Nickel. Making a 5-per cent. Nickel-cast-iron Alloy in an Electric Furnace, D. N. Witman. Trans. Am. Inst. Min. & Met. Engrs., no. 1087-S, August 1921, 4 pp., 1 fig. Discusses different alloys used for production of electrical-resistance grids.

Iron-Silicon System. On the Equilibrium Diagram of Iron-Silicon System, Takejifo Murakami. Science Reports Tôhoku Imperial Univ., vol. 10, no. 2, June 1921, pp. 79–92, 26 figs. Description of experiments carried out resulting in a revision of the equilibrium diagram by Guertler and Tammann.

IRON CASTINGS

Chill Castings. Chill Castings (Le Moulage en Coquille), A. Dat. Arts et Métiers, vol. 74, no. 9, June 1921, pp. 167–170, 11 figs. Discusses making of mold, pouring under pressure, etc.

Nickel and Cobalt in. Nickel and Cobalt in Iron, O. Bauer and E. Piwowarsky. Iron Age, vol. 108, no. 9, Sept. 1, 1921, p. 513. German experiments on iron castings; nickel improves physical properties. Translated from Stahl u. Eisen, Sept. 30, 1920.

IRON INDUSTRY

Brazil. Historical Data on the Brazilian Iron Industry (Några blad ur den brasilianska järnhanteringens historia), Harald Carlborg. Jerkontorets Annaler, vol. 105, no. 3, 1921, pp. 125–143. Contains also data on recent smelting practice.

L

LABOR

Hours of Work and Output. Hours of Work and Output. Eng. & Ind. Management, vol. 6, no. 5, August 4, 1921, pp. 122–124. Annual report of British Chief Inspector of factories and workshops.

Loss, Sources of. The Sources of Labor Loss, J. Burk LeClere. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 177–181. How they affect production through man power.

LABOR TURNOVER

Accidents In Relation to. The Unexpected Trend in Accident Prevention, C. B. Auel. Management Eng., vol. 1, no. 1, July 1921, pp. 35–41, 2 figs. Long service, good health, contentment, cleanliness, and carefulness are said to be more important than mechanical devices.

LATHES

Automatic. The Barker Two Period Alternating Automatic. Eng. Production, vol. 3, no. 45, August 11, 1921, pp. 124–125, 4 figs. Description of four spindle automatic lathe for bar work constructed by The Victor Engineering Co., Ltd., Glasgow, Eng.

LIGHTING

Canneries. Solving Special Lighting Problems in the Modern Cannery, Warren Alden. Jl. Elec. & Western Ind., vol. 47, no. 4, August 15, 1921, pp. 145, 1 fig. Describes illumination in plant of Pratt-Low Preserving Co., Santa Clara, Cal.

Industrial. Elimination of Waste in Industry Due to Poor Lighting, Ward Harrison. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 407–409, 6 figs. Points out importance of installation and proper maintenance of adequate illumination in avoidance of industrial accidents and resulting wastes of man power, losses of time, materials and production.

LIGNITE

Briquetting. The Economy of Briquetting (Die Wirtschaftlichkeit der Briketterzeugung), Otto Schöne. Braunkohle, vol. 19, nos. 50 and 51, Mar. 22 and 29, 1921, pp. 632–638 and 651–652, 2 figs. Writer demonstrates that in a properly equipped lignite briquet factory the actual loss through briquetting amounts to only 7.7 per cent.

The Loss of Fuel Through the Briquetting of Lignite (Der Brennstoffverlust durch die Brikettierung der Braunkohle), H. Berner. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 14 and 15, Apr. 8 and 15, 1921, pp. 108–110 and 116–117. Report of the expert committee of the Lignite Syndicate, showing that the original consumption of fuel in briquet factories amounting to 17 to 31 per cent represents an actual loss of only 8 per cent.

LOCOMOBILES

Robey. A 500-Horse-power Combined Engine and Boiler. Engineer, vol. 132, no. 3421, July 22, 1921, p. 88, 9 figs. on supp. plate and p. 94. Plant built by Robey & Co., Ltd., London, consists of compound engine mounted over circular boiler, having circular furnace and tubes which are withdrawable, and is provided with a superheater in smoke-box and a feedwater heater.

LOCOMOTIVE BOILERS

Tubes. Steel vs. Brass Locomotive Boiler Tubes (Le Tube de Chaudière de Locomotive acier ou laiton?), O. Hock. Revue Universelle des Mines, vol. 10, no. 3, August 1, 1921, pp. 261–269. Discusses experiences in various countries and shows that steel tubes are more economical.

LOCOMOTIVES

4-8-0. New 4-8-0 Type Locomotives for the Jamaica Government Railways. Ry. Gaz., vol. 35, no. 6, August 5, 1921, pp. 249–250, 3 figs. These engines were specially designed to work various classes of traffic on hilly sections of main line where heavy and long grades occur, with many curves of small radius.

Oil-Burning. Liquid-Fuel Burning Locomotives on British Railways—I. Ry. Engr., vol. 42, no. 499, August 1921, pp. 304–310, 11 figs. Describes recent developments with various companies. (To be concluded.)

Poppet-Valve Gear. A New Type of Poppet-Valve Gear in the Consolidation Locomotive no. 740. 324 F.S. (Su di un nuovo tipo di distribuzione a valvole applicato sulla locomotiva "Consolidation" no. 740.324 F.S.), Guido Corbellini. Rivista Tecnica delle Ferrovie Italiane, vol. 19, no. 6, June 15, 1921, pp. 152–170, 13 figs. Description of Caprotti type, and theoretical results expected from it. (To be continued.)

Shop Practice. Methods Employed in the Locomotive Shops of the Great Western Railway Co., Swindon—VII. Machinery (Lond.), vol. 18, no. 461, July 28, 1921, pp. 497–502, 16 figs. Discusses piston rings, piston crossheads, slippers, guidebars, etc.

Superheater, Oil-Fired. New Baldwin Locomotives For Cuba. Ry. Gaz., vol. 35, no. 8, August 19, 1921, pp. 315–316, 3 figs. Describes 0-8-0 shunting tank engine, 2-8-0 freight engine and 4-6-2 passenger locomotive, with superheater boilers and liquid-fuel-burning apparatus.

Tank. New Tank Locomotives, London & South Western Railway. Ry. Engr., vol. 42, no. 499, August 1921, pp. 285–288, 7 figs. Capable of exerting a tractive force of 34,000 lb., at 85 per cent of boiler pressure.

Tires, Machining. Tools for Boring and Turning Locomotive Tires—II, Fred H. Colvin. Am. Mach., vol. 55, no. 8, Aug. 25, 1921, pp. 313–317, 21 figs. Rough and finish turning tools. Solid tools and tools in holders. Angles of rake and clearance are said to vary greatly in different shops.

Winterthur Type. The New Locomotive of the Sumatra State Railway [Die neue Lokomotiven der Staatsbahnen auf Sumatra (Westküste)]. Siegfried Abt. Schwerizerische Bauzeitung, vol. 77, no. 7, Aug. 13, 1921, pp. 75–77, 5 figs. Specifications of Winterthur-type 0-D-1 wet-steam and 0-E-0 superheated-steam compound locomotives: Gage, 1067 mm.; cylinder bore, 450 mm.; piston stroke, 480 and 520 mm. respectively; wheelbase, 6.4 and 5 m. respectively; total heating surface, 103.2 and 102.36 sq.m. respectively; coal supply, 1200 kg.; weight empty, 38.54 and 41.92 tons respectively.

LUBRICANTS

Friction. The Theory of the Friction of Lubricants (Zur Theorie der Schmiermittelreibung), A. Sommerfeld. Zeit. für technische Physik, vol. 2, nos. 3 and 4, 1921, pp. 58–63 and 89–93, 6 figs. No. 3: Notes on dry and liquid friction; tests of the law of similarity. No. 4: Fundamental principles and quantitative results of the hydrodynamic theory of lubricants. Report of work by Lord Rayleigh.

LUBRICATING OILS

Specifications. Lubricating Oil Temperature Charts. Gas Age-Rec., vol. 48, no. 5, August 20, 1921, pp. 201–202, 2 figs. Show effect of viscosity on lubricating oils; gives specifications for selecting oils.

M

MACHINE DESIGN

Errors, Causes of. Common Causes of Errors in Machine Design, R. H. McMinn. Machy. (N. Y.), vol. 28, no. 1, Sept. 1921, pp. 38–39. Instructions and standards. Convenient form for data. Attitude toward errors. (Concluded.)

MACHINE GUNS

Barrels, Life of. Some Factors Affecting the Life of Machine-Gun Barrels, W. W. Sveshnikoff. Dept. Commerce, Technologic Papers Bur. Stand. no. 191, June 4, 1921, 27 pp., 19 figs. Results of experiments show that deterioration is due to combination of abrasive action of bullet and abrasion by hot gases.

MACHINE SHOPS

British. The Works of Messrs. Edgar Allen and Co., Limited, Sheffield. Engineering, vol. 112, nos. 2903, 2904 and 2905, Aug. 19, 26 and Sept. 2, 1921, pp. 272–274, 304–307 and 335–338, 32 figs. partly on supp. plates. Describes plant for making of manganese steel, tool steel, files, circular saws, twist drills, steel castings, railway and tramway special track work, crushing and grinding machinery, cement and powdered fuel plant, etc.

Famous British Works. Eng. Production, vol. 3, no. 45, August 11, 1921, pp. 122–123, 1 fig. Description of Rolls-Royce, plant at Derby, Automobile manufacturers.

Famous British Works. Eng. Production, vol. 3, no. 46, Aug. 18, 1921, pp. 146–149, 5 figs. Details of machine-tool works of Alfred Herbert, Ltd., Coventry.

Famous British Works. Eng. Production, vol. 3, no. 47, Aug. 25, 1921, pp. 170–172, 4 figs. Details of works of Robey & Co., Ltd., Lincoln, for manufacture of agricultural machinery, steam wagons, and all kinds of engines, including uniflow and semi-Diesel engines, air compressors, etc.

MACHINE TOOLS

Manufacture. Well House Foundry, Leeds. Engineer, vol. 132, no. 3424, Aug. 12, 1921, pp. 166–168, 11 figs. partly on pp. 164 and 170. Plant for construction of heavy machine tools and testing machines. Details of the different shops and some of machines constructed.

MACHINERY

Vibration. Elimination of Machine Vibration. Indian Industry & Power, vol. 18, no. 10, June 1921, pp. 529–531, 5 figs. Explains origin of vibrations and shows how to overcome them.

MALLEABLE IRON

American Foundry Practice. American Malleable Cast Iron—XIV–XVIII, H. A. Schwartz. Iron Trade Rev., vol. 69, nos. 2, 4, 6, 8 and 10, July 14, 28, Aug. 11, 25 and Sept. 8, 1921, pp. 98–101, 2 figs., 233–238, 8 figs., 354–359, 4 figs., 496–499, 3 figs., and 611–616, 9 figs. July 14: Cupola and open-hearth melting. July 28: Annealing practice. Aug. 11: Metallurgy of annealing. Aug. 25: Pattern-making and molding. Sept. 8: Cleaning and finishing.

MANUFACTURING

Special Tools vs. Standard Equipment. Manufacturing With Special Machines vs. Standard Equipment—IV, F. Jenks and M. H. Christopherson, Am. Mach., vol. 55, no. 9, Sept. 1, 1921, pp. 349–353, 13 figs. Portable devices for plain and thread milling. An angular drilling fixture. Special machine for milling sinuous oil grooves.

MARINE STEAM TURBINES

Geared. Geared Marine Turbines, C. R. Waller. Am. Mar. Engr., vol. 16, no. 10, May 1921, pp. 11–13, 4 figs. Gives description of type built by De Laval Steam Turbine Co.

MATERIAL HANDLING

Modern Methods. The Moving of Materials in Industry, R. M. Gates. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 65–70, 9 figs. Suggestions for better and greater application of mechanical material-moving devices.

MATERIALS

Testing. Material Testing in the German Material-Testing Bureau (Materialprüfung im Staatlichen Materialprüfungsamt). Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 12, 13 and 16, Mar. 25, Apr. 1 and 22, 1921, pp. 93–94, 101 and 124–125. (Abstract.) Report of State Material-Testing Bureau, Berlin-Lichterfelde, on work carried out in 1919–20.

MATTER

Changes of Form. Crystals, Solids and Vitreous Matter, A. Portevin. Sci. Am. Monthly, vol. 4, no. 2, Aug. 1921, pp. 137–141, 6 figs. Basic principles and general phenomena relating to changes of form in matter. Translated from La Revue de l'Ingénieur, April 1921.

MEASURING INSTRUMENTS

Electric Sensitive. Sensitive Measuring Apparatus, J. B. Moran. Machy. (N. Y.), vol. 28, no. 1, Sept. 1921, pp. 36–37, 2 figs. Describes electrical measuring device which is sensitive to one two-hundred millionths of an inch.

METAL SPRAYING

Meurer-Hopfelt Process. Metal-Spraying Machines (Die Metallspritzmaschine), M. Meurer. Autogene Metallbearbeitung, vol. 14, no. 11, June 1, 1921, pp. 159–166, 6 figs. Describes two types of the Meurer-Hopfelt machines, the one, used for cleaning as well as metallization, operates without heating of parts; the other, for metallization only, requires heating of metallizing drum and preheating of workpieces.

METALS

Calorizing. Protection of Metals by Calorizing (La Protection des Metaux Par la Calorisation). Le Génie Civil, vol. 79, no. 6, August 6, 1921, pp. 131–132, 6 figs. Discusses principles, advantages and difficulties of process.

MILLING MACHINES

Pressures Exerted by Cutters. Determining Pressures Exerted by Cutters. Can. Machy., vol. 26, no. 4, July 28, 1921, pp. 33 and 35, 3 figs. Describes device indicating pressures exerted on various parts of milling machine.

MINE HAULAGE

Rope Testing. Testing Rope and Driving Pulleys During Inspection Journey on the Volkenroda and Pöthen Potash Mines (Prüfung von Seil- und Treibscheibe während der Betriebsfahrt auf den Kalizecben Volkenroda und Pöthen), E. Jahnke and W. Heilmann. Kali, vol. 15, no. 14, July 15, 1921, pp. 229–231, 8 figs. Results of measurements made in March 1921, are shown in diagrams.

MINE HOISTING

Electric. Determination of Electrical Equipment for a Mine Hoist, Graham Bright. Min. & Metallurgy, no. 177, Sept. 1921, pp. 49–50. Discusses hoist calculation methods and selection of proper type of electrical equipment. (Abstract.) Paper read before Am. Inst. Min. & Metallurgical Engrs.

Electric Winding: Its Advantages and Economy A. B. MacLean. Mech. Wld., vol. 52, no. 1807, August 19, 1921, pp. 149–150. Discusses two cases in which cost of steam winding has been accurately obtained and wherein the steam conditions are typical of the locality. Abstract paper read before Assn. Min. Elec. Engrs.

Koepe Sheave. A Special Method of Replacing the Rope on a Koepe Sheave (Ein besonderes Verfahren des Auswechselns eines Koepe-Seils), A. Noack. Bergbau, vol. 34, no. 23, June 9, 1921, pp. 651–654, 2 figs. Describes method which can be employed with aid of steam cable and friction-gear winches, the only machine equipment required being the hauling engine and a small hand winch.

Rope Joints and Clamps. Rope Joints and Clamps (Seilverbindungen und Seilklammern), Karl Micksch. Bergbau, vol. 34, no. 24, June 16, 1921, pp. 685–688, 14 figs. Discusses various types.

MOLYBDENUM STEEL

Uses. Molybdenum Steel Uses Increase, M. H. Schmid. Iron Trade Rev., vol. 69, no. 9, Sept. 1, 1921, pp. 559–561. Use in manufacture of automobiles and other applications. Tests show properties of various alloys. (Abstract.) Paper presented before Am. Soc. for Steel Treating.

MONEL METAL

Impact Tests. Note on Notched Bar Impact Tests and Toughness of Monel Metal, R. G. Waltenberg, Chem. & Met. Eng., vol. 25, no. 8, August 24, 1921, pp. 322–323. Gives details of Charpy and Izod tests.

MOTOR BUSES

Railway-Track. Motor Omnibus For Railway Service. Tramway & Ry. Wld., vol. 50, no. 9, August 18, 1921, pp. 70–71, 4 figs. Built by J. G. Brill Co. for Chesapeake Western R. R. Is a one-man bus.

MOTOR-TRUCK TRANSPORTATION

Comparison with Railways. The Motor Truck and the Railroad, Rollin W. Hutchinson. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 131–138, 4 figs. A forecast of future of motorized highway commerce.

MOTOR TRUCKS

English. A Remarkable New Transport Vehicle. Motor Transport, vol. 33, no. 860, August 22, 1921, pp. 200–201, 2 figs. Describes a transport truck made by Haulage Improvements & Constructions, Ltd., Lond.

Steam. The Clarkson Steam Lorry. Engineering, vol. 112, no. 2903, Aug. 19, 1921, pp. 275–278, 12 figs. New type of vehicle which burns coke. Details of engine, boiler, etc.

N

NITROGEN

Fixation. Commercial Production of Atmospheric Nitrogen, by the Flaming Electric Arc (Lo Sfruttamento Industriale dell'Azoto Atmosferico, per Mezzo dell'Arco Elettrico a Fiamma). Il Forno Elettrico, vol. 3, no. 4, April 15, 1921, pp. 51–56, 3 figs. Describes arrangement using high-tension a.c. and d.c. electromagnet. (Concluded.)

Supplementary Report on Nitrogen Products. Chem. Age, vol. 5, no. 112, August 6, 1921, pp. 148–151. Discusses progress of fixation of nitrogen in various countries.

Recovery by Activated Sludge Process. Nitrogen—with Special Reference to Activated Sludge, Gilbert J. Fowler. Eng. News-Rec., vol. 87, no. 8, Aug. 25, 1921, p. 311. (Abstract.) Monograph entitled The Conservation of Nitrogen with Special Reference to Activated Sludge, comprising Dec. issue of Jl. Inst. of Sci., Bangalore, India.

O

OIL ENGINES

Double-Acting Two-Stroke Marine. The First Motor Ship with Double-Acting Two-Stroke Engines, R. Dreves. Engineer, vol. 132, no. 3425, Aug. 19, 1921, pp. 191–192, 1 fig. Describes engines installed on twin-screw cargo vessel, Fritz, having three working cylinders of 480 mm. diam. and 710 mm. stroke, and developing 830 brake hp. at 120 r.p.m. Account of trial trips with ship which was delivered to England in November 1919, according to terms of Peace Treaty.

Marine. Some Observations on Marine Oil Engines, D. M. Shannon. Mech. Wld., vol. 52, no. 1807, August 19, 1921, pp. 143–144, 11 figs. Discusses Diesel and hot-bulb engines. (To be continued.) From paper read before Inst. Mar. Engrs.

Opportunity of. Waste of Coal and Oil Fuel. Gas & Oil Power, vol. 16, no. 191, August 4, 1921, pp. 165–167, 2 figs. Discusses opportunity of the small oil and the Diesel engine.

OIL FIELDS

Mexico. Mexican Oil Fields, L. G. Huntley and Stirling Huntley. Min. & Metallurgy, no. 177, Sept. 1921, pp. 27–32, 3 figs. Survey of producing areas, known reserves, and geological factors which point to important development.

OIL SHALES

Esthonia. The Oil Shales in Esthonia (Ueber die Oelschiefer in Esthland), C. Gäbert. Braunkohle, vol. 19, nos. 48 and 49, Mar. 12 and 17, 1921, pp. 597–610 and 613–625, 26 figs. partly on supp. plate. Large stretches of bituminous shales occur in slight depths in the rock foundations of Esthonia. Bibliography. General geological and topographical conditions. Chemical and technical conditions.

Rocky Mountains. Notes on the Oil-Shale Industry With Particular Reference to the Rocky Mountain District, M. J. Gavin, H. H. Hill and W. E. Perdew. Reports of Investigations Dept. of Interior Bur. of Mines, Serial no. 2256, June 1921, 36 pp., 2 figs. Discusses mining, retorting, refining in Scotland and in U. S.

Thermal Decomposition. The Thermal Decomposition of Oil Shales—II, Ralph H. McKee and E. E. Lyder. Jl. Ind. & Eng. Chem., vol. 13, no. 8, August 1921, pp. 678–684, 3 figs. Determination of heat of reaction involved in their thermal decomposition. Results of experiments show that decomposition takes place between 400 and 410 deg. cent.

OIL WELLS

Production. Some Principles Governing the Production of Oil Wells, Carl H. Beal and J. O. Lewis. Petroleum Times, vol. 6, no. 135, August 6, 1921, pp. 183–185. Discusses natural and artificial influences in yield of wells. (To be continued.)

OILS

Soy-Bean. Soy-Bean Oil: Factors Which Influence Its Production and Composition, Carl R. Fellers. Jl. Ind. & Eng. Chem., vol. 13, no. 8, August 1921, pp. 689–691. Discusses physical and chemical properties, oil and protein content, and effect of planting date on composition.

OPEN-HEARTH FURNACES

Gas-Fired. The Heating of Open-Hearth Furnaces with a Mixture of Lignite-Briquet and Blast-Furnace Gas (Die Beheizung von Martinöfen mit einem Gemisch von Braunkohlenbrikett- und Hochofengas), Fritz Boettcher. Stahl u. Eisen, vol. 41, no. 30, July 28, 1921, pp. 1027–1030, 4 figs. It is shown that smelting with such mixture is possible under given conditions. The producer must be operated

as slowly and as cold as possible, and the furnaces must permit of transmission of larger quantities of gas through furnace space with greater speed.

OXY-ACETYLENE CUTTING

Radiograph and Oxygraph Machines. Oxy-Acetylene Cutting Machines. Engineering, vol. 112, nos. 2903, 2904 and 2905, Aug. 19, 26 and Sept. 2, 1921, pp. 274-275, 307-311 and 356-357, 30 figs. Constructed by Davis-Bournonville Co., Jersey City N. J. Aug. 19: Details of the radiograph machine for cutting metal up to 20 or 22 in. thick in straight lines or to circular profiles. Aug. 26 and Sept. 2: The oxygraph machines nos. 1A and 2A.

P

PAINTS

White Lead. White Lead in Painting. Engineering, vol. 112, no. 2904, Aug. 26, 1921, pp. 323-324. Outline of statement issued by London Chamber of Commerce entitled Case Against Prohibition, in connection with subject to be discussed at Int. Labor Conference at Geneva, Oct. 25 on the prohibition of use of white lead in painting.

PATENT LAWS

Needed Improvements. The Patent Situation, Edwin J. Prindle. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 417-419. Claims that inadequate salaries and insufficient personnel are causes of waste in patent office for which industry must pay in costly delays and burdensome litigation. Analysis of legislation designed to remedy situation

PEAT

Production and Refinement. New Methods and Future Problems in the Peat Industry (Neue Wege und Zukunftsaufgaben der Torfindustrie), H. R. Trenkler. Feuerungstechnik, vol. 9, no. 20, July 15, 1921, pp. 185-186. Discussion of modern processes for recovery and refinement of peat, based on papers by Karl Birk presented before Soc. for Promotion of Moor Coal Cultivation.

PETROLEUM

Distillation. Mineral Oil Distillation. Petroleum Wld., vol. 18, no. 251, August 1921, pp. 313-320, 4 figs. Discusses questions of dephlegmation and preheating. (To be continued.)

Galicia. Galician Oil (Il Petrolio Galiziano), L. Maddalena. Revista Tecnica delle Ferrovie Italiane, vol. 19, no. 6, June 15, 1921, pp. 171-180, 2 figs. Discusses geology and resources, conditions of industry, and Italian interests in Galician oil.

Refining. Minimizing Heat Losses in Oil Refining. Min. & Oil Bul., vol. 7, no. 9, August 1921, pp. 537-539 and 563, 4 figs. Discusses high-temperature heat insulators as applied to various stills.

The Refining of Petroleum, C. K. Francis. Min. & Oil Bul., vol. 7, no. 9, August 1921, pp. 524-528 and 563, 2 figs. Discusses fractional distillation, gasoline, naphtha, lubricating oils, wax, petrolatum, etc.

PHOTOMETERS

Reflectometers. The Ball Photometer as Reflectometer (Das Kugelphotometer als Reflektometer), R. Ulbricht. Zeit. für Beleuchtungswesen, vol. 27, no. 13-14, July 15-31, 1921, pp. 51-54, 3 figs. Notes on Taylor's portable reflectometer described in Elec. World (Sept. 4, 1920, p. 467), and author's own work, entitled the ball photometer, published by R. Oldenbourg, Münich and Berlin.

PIPE

Flange Joints. Jointing Material for Pipe Flanges (Etwas über Flanschen-Dichtungsmaterial). Elektrotechnischer Anzeiger, vol. 38, no. 93, June 14, 1921, pp. 627-630. Deals with different kinds of jointings for pipe flanges for steam and gases of high and low pressure and different temperatures, as well as for such liquids as water, oil, tar, acids, alkalis, etc.

PIPE LINES

Wood-Stave. Wood Pipe Lines in New England Hydroelectric Development. Elec. Rev. (Chicago), vol. 79, no. 8, August 20, 1921, pp. 265-268, 8 figs. Also in Eng. Wld., vol. 19, no. 2, Aug. 1921, pp. 77-80, 8 figs. Some data on recent wood-stave construction.

PISTONS

Light-Metal. Light Metal Pistons for Engines (Leichtmetallkolben für Motoren), R. Krüger. Oel- u. Gasmaschine, vol. 18, no. 7, July 1921, pp. 105-110, 7 figs. Notes on material, manufacture and life of aluminum pistons; pressing and casting processes; Dow-metal pistons.

Machining. Machining One Hundred Engine Pistons per Hour, J. H. Moore. Can. Machy., vol. 26, no. 6, August 11, 1921, pp. 25-27, 12 figs. Examples of work produced including valve stem guide, engine valve cage, etc.

PLANERS

Mechanical Reversing Drive. A Mechanical Reversing Drive for Planing Machines. Engineer, vol. 132, no. 3422, July 29, 1921, pp. 124-125, 3 figs. Details of the Newton-Derby patented reversing drive.

Newton Planer Reversing Drive. Machinery (Lond.), vol. 18, no. 461, July 28, 1921, pp. 515-517, 4 figs. Application of epicyclic reduction gearing.

POWER PLANTS

Developments. Developments in Power Station Design—V. Engineer, vol. 132, no. 3425, Aug. 19, 1921, pp. 190-191, 4 figs. Details of the Bettington boiler arranged for burning pulverized coal, constructed by Fraser & Chalmers, Ltd.

Hershey Chocolate Co. Hershey Chocolate Company's New Power Plant. Power, vol. 54, no. 4, July 26, 1921, pp. 124-131, 8 figs. Plant laid out for 7500 kw. at 80 per cent power factor, in four 2300-volt units, and ten water-tube boilers each having 7444 sq. ft. of heating service. Two 1250-kw. 80-per cent power-factor turbo-generators and four boilers installed. Bleeder-type turbines are used and equipped with surface condensers.

Industrial. Industrial Power-Plant Data. Power, vol. 54, no. 4, July 26, 1921, pp. 139-140. Census figures from 26 states covering primary power in manufacturing establishments.

Seward, Pa. Power Plant Designed to Meet Conditions in Coal-Mining District, W. P. Gavit. Power, vol. 54, no 8, Aug. 23, 1921, pp. 278-286, 12 figs. Seward power station of Penn Public Service Corp. designed for 100,000 kw.; 40,000-kw. installed in two 20,000-kw. units. Boilers contain 16,000 sq. ft. of heat surface each. Automatic control of boiler operation.

PRECIPITATION

Electrical. Eliminating Waste and Nuisance in Smoke, Fume and Gas, P. E. Landolt. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 428-432, 6 figs. Notes on electrical-precipitation methods in metallurgical, and chemical industries, and in other fields. Costs. Bibliography.

Extracting Flue Dust Electrically, N. H. Gellert. Iron Trade Rev., vol. 69, no. 2, July 14, 1921, pp. 102-105, 3 figs. Describes principle involved in precipitating dust by Cottrell process and method of operating an electrolytic cleaner. Comparison of various types of gas-cleaning equipment. (Abstract.) Paper presented before Assn. Iron & Steel Elec. Engrs.

PRESSES

Safeguarding. Safety Devices for Power Presses. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1106-1109, and vol. 28, no. 1, Sept. 1921, pp. 40-42, 16 figs. Guards and safety measures provided for power-press equipment in Cleveland Metal Products Co.'s plant, Cleveland, Ohio.

PRESSWORK

Tools. An Interesting Press Job. Eng. Production, vol. 3, no. 47, Aug. 25, 1921, pp. 173-174, 10 figs. Tools for producing curtain holders.

PROFIT SHARING

British Plan. British Plan of Profit Sharing, T. Sington. Am. Gas Jl., vol. 115, no. 8, August 20, 1921, pp. 165-166. Discusses method adopted by gas companies.

PULVERIZED COAL

Advantages and Disadvantages. Pulverized Coal Firing (Allgemeines über Staubkohlenfeuerung), H. Richarz. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 15, Apr. 15, 1921, pp. 113-116. Nature and useful scope, advantages and disadvantages. Bibliography. (Abstract.) Address before Soc. German Engrs.

Boiler Firing. Firing With Pulverized Coal (Le Chauffage au Charbon Pulvérisé), Paul Frion. Chaleur et Industrie, vol. 2, no. 15, July 1921, pp. 433-439. Discusses application of pulverized coal for furnaces and steam generator, also its drawbacks and dangers. (Concluded.)

Use of Pulverized Coal in Steam Power Plants, H. A. Reichenbach. Elec. Rev. (Chicago), vol. 79, no. 8, August 20, 1921, pp. 261-264, 5 figs. Method employed in handling and preparing fuel for delivery to furnace. Pipe line used to convey pulverized coal 1000 ft. Some tests results with anthracite silt and bituminous coal.

Work of the Commission For Fuel Utilization (Travaux de la Commission d'Utilisation des Combustibles), Paul Frion. Bulletin de la Société d'Encouragement pour L'Industrie Nationale, vol. 133, no. 5, May 1921, pp. 477-507. Report of third sub-committee. Firing with powdered coal. Report on investigation for and against use of powdered coal, recommending its use where suitable.

Gasification. A New Method for the Gasification of Pulverized Coal (Ein neues Verfahren zur Staubkohlenvergasung), K. M. Bailey. Chemiker-Zeitung vol. 45, no. 99, Aug. 18, 1921, pp. 789-790, 2 figs. Describes method, its application and operation of plant.

Power Stations. Developments in Power Station Design. Engineer, vol. 132, nos. 3420, 3421, 3423 and 3424, July 15, 22, Aug. 5 and 12, 1921, pp. 70-71, 90-91, 142-144 and 162-163, 11 figs. Notes on by-products and waste heat, and pulverized coal. Different types of pulverized fuel plants, installed in English and American power plants.

Pulverizing Machine. The "Atritor" Coal Drying and Pulverizing Machine. Engineer, vol. 132, no. 3423, Aug. 5, 1921, p. 150, 1 fig. Details of new machine recently installed in cement works in Midlands, England. Advantages.

PUMPS, CENTRIFUGAL

Electrically Driven. Recent Installation of Centrifugal Pumps in Brockton Sewage Pumping Station, E. F. Leger. Am. City, vol. 25, no. 3, Sept. 1921, pp. 185-190, 2 figs. Transition from original pumping equipment of triple-expansion, steam-driven reciprocating pumps to electrically driven centrifugal pumps for pumping city sewage.

PYROMETERS

Optical. A Simple Optical Pyrometer (Ein einfaches optisches Pyrometer), H. Lux. Glasers Annalen für Gewerbe u. Bauwesen, vol. 89, no. 1, July 1, 1921, pp. 13-14, 2 figs. The Lummer-Kurlbaum pyrometer.

R

RAILS

Rerolling Discarded Steel. Rerolling Discarded Steel Rails, John D. Knox. Iron Trade Rev., vol. 69, no. 4, July 28, 1921, pp. 226-231, 10 figs. Practice as followed by Sweet's Steel Co. in preparing broken sections for mills. Description of plant.

RAILWAY ELECTRIFICATION

Advantages. The Electrification of Main Line Railways in Relation to Traffic Working, Philip Nash. Jl. Inst. of Transport, vol. 2, no. 5, March 1921, pp. 194-202 and (discussion) pp. 202-207. Discusses pros and cons of electricity and steam for freight haulage.

Germany. History of the Electrification of the Former Prussian-Hessian State Railways (Geschichte der elektrischen Zugförderung auf den ehemaligen preussisch-hessischen Staatseisenbahnen), Karl Trautvetter. Archiv für Eisenbahnwesen, nos. 3 and 4, May-June and July-Aug., 1921, pp. 582-595 and 793-812, 10 figs. History of development and progress since 1896.

RAILWAY MOTOR CARS

Gasoline. Petrol Rail Cars for India. Engineer, vol. 132, no. 3419, July 8, 1921, pp. 44-45, 5 figs. Describes 2-ft. 6-in.-gage 50-hp. petrol cars built for Kalka-Simla Railway by Drewry Car Co., Ltd., London.

RAILWAY OPERATION

Automatic Train Control. Problems of Automatic Train Control. Ry. Engr., vol. 42, no. 499, August 1921, pp. 311-315. Discusses various problems and cost of installation, principles of communication, etc.

Ceylon. The Ceylon Government Railways—II. Ry. Gaz., vol. 35, no. 6, August 5, 1921, pp. 257-258. Abstract from British government report on administration and working of railroad. (To be concluded.)

Economics. Economics of Railway Transport, and Methods of Raising Revenue, J. George Beharrell. Jl. Inst. of Transport, vol. 2, no. 5, March 1921, pp. 218-232, 7 figs. Discusses density of traffic, revenue and costs, rate-fixing machinery, commodity ton miles, etc.

Slow-Freight Traffic. On the Question of Slow Freight Traffic, U. Lamalle. Bul. International Ry. Assn., vol. 3, no. 7, July 1921, pp. 857-884, 10 figs. Discusses freight wagons, organization of train services, influence of rating on working capacity of rolling stock.

Trains over One-Way Divisions. The Operation of Trains over One-Way Divisions (Der Zuglauf bei Bahnen mit nur in einer Fahrrichtung benutzten Streckengleisen), H. Gaede. Archiv für Eisenbahnwesen, nos. 1, 2, 3 and 4, Jan-Feb., Mar-Apr., May-June and July-Aug., 1921, pp. 52-95, 358-386, 535-563, and 765-792, 38 figs. Author seeks to formulate the most important laws governing operation of trains on one-way divisions. Bibliography.

RAILWAY REPAIR SHOPS

Methods. Railway Machine Shop Practice. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1098-1099, 5 figs. Methods of procedure in making common types of repairs that are required on passenger and freight cars.

Tools. Forge Shop and Other Railroad Shop Tools, Frank A. Stanley. Am. Mach., vol. 55, no. 9, Sept. 1, 1921, pp. 354-356, 11 figs. Tools and methods in use in western railroad shop. Special equipment to utilize air. Modern method of cleaning castings.

RAILWAY SHOPS

Lincoln, England. The Works of Clayton Wagons Limited, at Lincoln. Ry. Gaz., vol. 35, no. 6, August 5, 1921, pp. 251-255, 7 figs. Describes new works laid out for economical construction of railway rolling stock.

RAILWAY SIGNALING

Automatic. The Automatic Signaling Installation of the Berlin Electric Underground Railway and Certain Types of Pilots (Die selbsttätige Signalanlage der Berliner Hoch- und Untergrundbahn nebst einigen Vorläufern), G. Kemmann. Zeit. für Kleinbahnen, vol. 27, nos. 11 and 12, Nov. and Dec. 1920, pp. 392-402 and 438-457, 24 figs. partly on supp. plates. Nov.: Details of the separate parts of interlocking plant (Westinghouse system): illuminated signal boards; the d.c. relay; and the d.c. lamp signal box. Dec.: Safety installations in the Spittelmarkt station.

RAILWAY TRACK

Maintenance. Note on Mechanical Permanent Way Repairing Plant, M. Cartault. Engineering, vol. 112, no. 2903, Aug. 19, 1921, pp. 281-282. Describes use and mechanical equipment of the Collet system, in use since 1901 on Paris, Lyons & Mediterranean Ry. permanent way. Reprinted from Bul. Int. Ry. Assn.

Roadbed. On the Question of the Construction of the Road Bed and of the Track, Charles H. Ewing. Bul. International Ry. Assn., vol. 3, no. 7, July 1921, pp. 835-856, 11 figs. Discusses questions of ballasts, rails, tie plates, etc. and gives list of replies received from railway companies to a question blank.

ENGINEERING INDEX (Continued)

RAILWAY YARDS

Illumination. Correct Illumination of Railway Freight Yards, J. H. Kurlander. Ry. Elec. Engr., vol. 12, no. 8, August 1921, pp. 299–306, 13 figs. Also in Ry. Age, vol. 71, no. 8, Aug. 20, 1921, pp. 337–340, 9 figs. Mounting height of lighting units is of prime importance in eliminating glare and obtaining best results. Bibliography.

REDUCTION GEARS

Heliocentric. The Heliocentric Reduction Gear. Machinery, (Lond.), vol. 18, no. 464, August 18, 1921, pp. 598–599, 3 figs. Describes new type of speed-reducing gear invented by W. C. Pitter and manufactured by Central Gear Co., Lond.

REFRACTORIES

Jointing Materials for. Notes on Jointing Materials for Refractories, L. Bradshaw and W. Emery. Gas Jl., vol. 155, no. 3036, July 20, 1921, pp. 157–159, 1 fig. Discusses jointing materials for refractories and influence of oxidizing and reducing atmospheres on refractory materials.

REFRIGERATING PLANTS

Electric-Motor Drive. Electric Motors for Driving Refrigeration Plants—Their Types, Characteristics, and Selection. W. H. Motz. Power, vol. 54, no. 6, Aug. 9, 1921, pp. 208–211, 5 figs. Discusses use of compound and synchronous motors.

Fish Refrigeration. New and Convenient Arrangement for Refrigerating Large Quantities of Fish (Un Dispositif Pratique et Nouveau Pour la Congélation de Grandes Masses de Poissons), Georges Delhoste. L'Outillage, vol. 219, no. 31, August 4, 1921, pp. 841–843, 7 figs. Describes unique installation, property of British Government.

REFRIGERATING MACHINES

Carbon-Dioxide. Refrigerating Machines (Machines Frigorifiques), A. Rullier. Arts et Métiers, vol. 74, no. 8, May 1921, pp. 150–153, 5 figs. Describes recent improvements in CO_2 machines.

ROLLING

Non-Metallic Products. The Rolling of Non-Metallic Products, Morris A. Hall. Raw Material, vol. 4, no. 8, August 1921, pp. 273–278, 9 figs. Discusses kinds of rolls in use in paper, textile and other non-metallic industries.

ROLLING MILLS

Homecourt, France. Completes French Rolling Mills. Iron Trade Rev., vol. 69, no. 8, Aug. 25, 1921, pp. 480–483, 5 figs. Pittsburgh company builds 44-in. reversing blooming mill, 48-in. universal plate mill and auxiliary machinery to be installed in plant at Homecourt. Description and layout of equipment.

Roll Making. How Steel Mill Rolls Are Made—II, H. E. Diller. Foundry, vol. 49, no. 16, August 15, 1921, pp. 631–638, 15 figs. Discusses metallurgy, melting and casting practice.

Making Rolls for Steel Mills, H. E. Diller. Iron Trade Rev., vol. 69, nos. 7 and 9, Aug. 18 and Sept. 1, 1921, pp. 419–424 and 432 and 547–554, 25 figs. Aug. 18: Different types of melting furnaces preferred for steel, chilled-iron hot, and chilled cold rolls. Sept. 1: Methods of molding steel and sand-cast rolls. How proper allowance for shrinkage is made in determining size and shape of chills.

Sheet Mills. Builds New Sheet Mill in East, E. C. Kreutzberg. Iron Trade Rev., vol. 69, no. 2, July 14, 1921, pp. 89–91, 5 figs. Plant in Baltimore designed for annual output of 70,000 tons of full finished stock. Labor-saving devices.

ROOFS

Tile. The Neupert Cantilever Tile Roof (Das Neupertsche freitragende Ziegeldach), H. Nitzsche. Beton u. Eisen, vol. 20, nos. 9–10 and 11, June 4 and July 4, 1921, pp. 108–111 and 127–128, 14 figs. Brief description of construction system with hollow brick, supporting capacity of which was confirmed by test load carried out by author in 1919. Static calculation of roof.

RUBBER

Technology. Rubber—From the Sap to the Finished Product, W. H. Holmes. Raw Material, vol. 4, no. 8, August 1921, pp. 281–289, 8 figs. Discusses principal rubber products: washing, drying and grinding machines; rubberized cloth; waterproofing, etc.

Vulcanization. Accelerators for Vulcanizing (Les Accélérateurs de la Vulcanisation), A. Neef. Révue Universelle des Mines, vol. 9, no. 1, S. 6, April 1, 1921, pp. 51–56. Discusses variety of organic accelerators in vulcanizing of rubber, their action, and future of process.

Vulcanized, Hardness of. The Modulus of Hardness of Vulcanized Rubber, H. P. Gurney. Jl. Ind. & Eng. Chem., vol. 13, no. 8, August 1921, pp. 707–712, 11 figs. Describes spring type and dead weight type of instruments for determining hardness.

S

SAFES

Reinforced-Concrete. The Thörig Reinforced-Concrete Safes Without Iron or Steel Casing (Kassenschränke aus bewehrtem Beton ohne Eisen- oder Stahlummantelungen nach "Bauweise Thörig"). Beton u. Eisen, vol. 20, no. 7–8, May 4, 1921, pp. 81–84, 14 figs. Describes patented system, according to which body of safe and door are made in iron forms as a monolithic whole, whereby outside and inside iron or steel linings are entirely eliminated and use of iron is otherwise reduced to a minimum. Use of reinforced concrete in place of iron is said to greatly increase safety against burglary.

SAND BLAST

Automobile Construction. The Use of Sand Blasts in the Construction of Automobiles and Engines (Die Verwendung von Sandstrahlgebläsen im Kraftwagen- und Motorenbau), W. Kaempfer. Motorwagen, vol. 24, no. 15, May 31, 1921, pp. 297–302, 13 figs. Enumerates purposes for which sand-blasting can be used in construction of automobiles and engines; and describes three different systems, the suction, gravity and pressure system.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCRAP

Losses, Regulating. Regulating Losses from Scrap, Herbert R. Simonds. Iron Trade Rev., vol. 69, no. 3, July 21, 1921, pp. 157–161, 10 figs. Distinguishing between avoidable and unavoidable waste. Change in design often reduces scrap loss. Proper marketing.

SEAPLANES

Fairey Type III D. The Fairey Type IIID Seaplane. Flight, vol. 13, no. 33, August 18, 1921, pp. 552–557, 27 figs. Describes 360 hp. Rolls-Royce "Eagle" engine.

[See also FLYING BOATS.]

SEARCHLIGHTS

Anti-Aircraft. Tactical Organization and Employment of Anti-Aircraft Searchlights, John S. Pratt. Jl. U. S. Artillery, vol. 55, no. 2, August 1921, pp. 102–170, 24 figs. Discusses desirable characteristics, protection and concealment, night bombing flights, anti-aircraft defense, etc.

SEMI-DIESEL ENGINES

Operation. Semi-Diesel Engines (Les Moteurs Semi-Diesel). La Nature, no. 2463, June 18, 1921, pp. 395–398, 2 figs. Describes method of working generally and combustion chamber in particular.

SLAG

Blast-Furnace. Methods of Preparing Blast Furnace Slag. Iron Age, vol. 108, no. 8, Aug. 25, 1921, pp. 461–463, 4 figs. Divided into four classes by Carnegie Steel Co. according to specific use to which it is to be put.

SLOTTING

Machines for. Slotting Operations on Production Work. Machinery, (Lond.), vol. 18, no. 464, August 18, 1921, pp. 604–609, 12 figs. Discusses vertical planing, shaping, slotting and keyseating operations.

Slotting Operations on Production Work, Edward K. Hammond. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1117–1122, 11 figs. Tooling up slotters and keyseaters for performance of vertical planing, shaping, slotting, and keyseating operations.

SPRINGS

Leaf. Formulas for Calculating Leaf Springs (Détermination de Formules Pratiques Pour le Calcul des Ressorts a Lames), H. Chaullet. Arts et Métiers, vol. 74, no. 8, May 1921, pp. 145–149, 7 figs. Works out formulas for various kinds.

STANDARDIZATION

German N. D. I. Report. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 20, July 10, 1921, pp. 299–315, 23 figs. Proposals of Board of Directors for cotters; round threads; hexagonal and square-head bolts and nuts, carriage and countersunk bolts, lag screws, etc. Proposed standards for double anchor plates for T-head anchor bolts; wall anchor plates; T-head bolts; square nuts for anchor bolts, paper sizes, etc.

STANDARDS

Limit Dimensions. Determination of the Required Allowance Dimensions for Various Cylindrical Machine Parts (Feststellung der erforderlichen Passmasse für die verschiedenen Fabrikate), W. Kühn. Werkstattstechnik, vol. 15, no. 14, July 15, 1921, pp. 421–426, 7 figs. Notes on practical application of limit dimensions established by German Industry Committee on Standards (NDI).

STEAM

Dissociation. Steam Dissociation and Steam Jet Blowers in Theory and Practice (Wasserdampfzerfall und Dampfstrahlgebläse in Lehre und Anwendung), Hch. Doevenspeck. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 14, Apr. 8, 1921, pp. 105–108, 2 figs. Points out that from practical standpoint the problem of turbo-blowers has not yet been solved, whereas the electric motor in boiler-room operation has proved to be both safe and economical.

Flow in Pipes. Convenient Tables for Steam Flow in Pipes, V. F. Davis. Power, vol. 54, no. 4, July 26, 1921, pp. 144–145. Table giving steam flow in pounds per minute for 100-ft. pipe and 1-lb. pressure drop; and factors to be applied to table for various lengths and pressure drops.

Specific Heat. Measurements of the Specific Heat of Steam and Its Technical Importance (Die bisherigen Messungen der spezifischen Wärme des Wasserdampfes und ihre technische Bedeutung), H. Schmolke. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 1 and 2, Jan. 7 and 14, 1921, pp. 3–4 and 12–13. History of development of investigations culminating in work of G. Eichelberg published in 1920.

STEAM ENGINES

Still Steam-Gas Type. The Still Engine (Der Still-Motor), H. Schuster. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 16, Apr. 22, 1921, pp. 121–123, 3 figs. Discusses the Still combination internal-combustion and steam engine and prospects of its use for locomotive drive.

Uniflow. A Uniflow Engine Set at Slough. Elec. Times, vol. 60, no. 1556, August 11, 1921, pp. 123–124, 2 figs. Consists of Sulzer horizontal single-cylinder Uniflow direct-coupled to Oerlikon three-phase a.c. generator.

STEAM PIPING

Flange Blanks. Safety Flange Blanks (Sicherheitsflanschstücke). Der praktische Maschinen Konstrukteur, vol. 54, no. 23, June 9, 1921, p. 181, 3 figs. According to arrangement devised by Eisenberg & Schmöger, Dortmund, Germany, the cleaning or repairing of a battery can be effected without removing connecting pipe between boiler and collector, by adjusting between boiler and collector a pipe section as valve casing.

Reducing Costs of. Saving Effected Through Use of Valves with Low Resistance (Ersparnisse durch Verwendung von Absperrvorrichtungen mit geringem Einzelwiderstand), Karl Schmidt. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 13, Apr. 1, 1921, pp. 97–101. It is shown how, under otherwise uniform conditions, installation and operating costs of pipe lines can be reduced when the separate resistance of the installed construction parts (especially the valves) are diminished.

STEAM TURBINES

Heating Steam from. Non-Condensing Turbine Operation on Heating Load, R. D. DeWolf. Power, vol. 54, no. 6, Aug. 9, 1921, pp. 220–221, 2 figs. Decentralized plants or units to recover electrical energy from heating steam. It is proposed to limit attendance for these machines to periodic inspection. Paper presented before Nat. Dist. Heating Assn.

STEEL

Alloy. See ALLOY STEELS.

Classification Code. Universal Steel Classification Code, Horace C. Knerr and Arthur L. Collins. Iron Age, vol. 108, no. 9, Sept. 1, 1921, pp. 515–517. Proposed new code to supplant present S.A.E. system. Claimed to be simpler, more elastic and easily expanded.

Drill. Manufacture of Drill Steel from Hollow Ingots. P. A. E. Armstrong. Iron Age, vol. 108, no. 10, Sept. 8, 1921, pp. 596–598, 2 figs. Process used by Ludlum Steel Co. and its advantages. Abstract of paper read before Am. Inst. Min. & Metallurgical, Engrs., with additional details and illustrations.

Endurance. Relations Between The Physical Properties of Steels and Their Endurance of Service Stresses, James E. Howard. Trans. Am. Soc. for Steel Treating, vol. 1, no. 11, August 1921, pp. 673–682. Discusses state in which steel best meets the conditions of service.

Ingots, Welding Defective. Welding Defective Steel Ingots, H. Brearley. Iron Trade Rev., vol. 69, no. 5, Aug. 4, 1921, pp. 289–292. Discusses blow-holes and segregate effect. Explains test method for determining extent of interior influences. Method of casting ingot is said to regulate imperfections. Paper read before Iron & Steel Inst.

Molybdenum. See MOLYBDENUM STEEL.

Silicon Additions. Silicon Additions to Steel. Iron Age, vol. 108, no. 8, Aug. 25, 1921, p. 458. Effect of early and late introduction on gas content and rolling discard. Translated from article by Piwowarsky in Stahl u. Eisen, June 10, 1920.

Tool. See TOOL STEEL.

STEEL CASTINGS

Electric vs. Open-Hearth Furnaces. Compares Costs of Melting Steel. Iron Trade Rev., vol. 69, no. 3, July 21, 1921, pp. 167–170, 3 figs. Producer of steel castings operating both an electric and an open-hearth furnace gives data covering the two processes from which estimated costs are calculated.

STEEL FOUNDING

Converter Flame Examination. Spectroscopic Examination of Converter Flame, W. J. Campbell. Engineer, vol. 132, no. 3423, Aug. 5, 1921, pp. 137–138. Notes on the spectroscope and advantage of its use for many classes of small foundry work. Table giving outline of average blow and its spectroscopic examination.

STEEL, HEAT TREATMENT OF

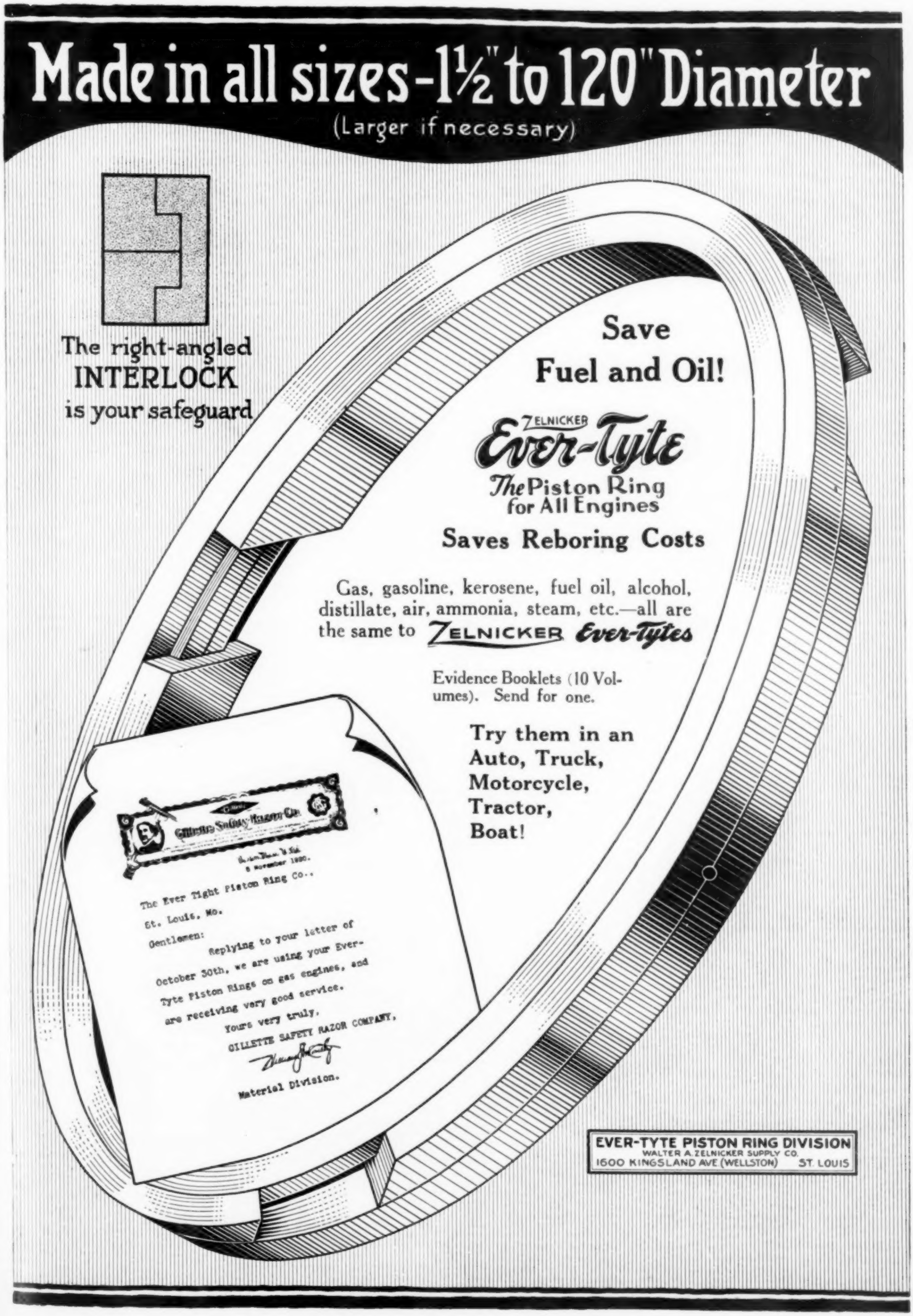
Effect on Fatigue Strength. Effect of Heat Treatment on the Fatigue-Strength of Steel, E. P. Stenger and B. H. Stenger. Trans. Am. Soc. Steel Treating, vol. 1, no. 11, August 1921, pp. 617–635 and (discussion) pp. 635–638, 15 figs. Discusses effect of cold rolling and cold drawing, also effect of carbon content.

Temperature and Quality. The Carbonizing Process—Relation of Temperature to Quality of Cast and Core, Theodore G. Selleck. Trans. Am. Soc. Steel Treating, vol. 1, no. 11, August 1921, pp. 655–666, 9 figs. Gives a number of heat-treatment curves.

STEEL MANUFACTURE

American vs. English Practice. British View of American Steel Making, R. Percival Smith. Iron Age, vol. 108, no. 10, Sept. 8, 1921, pp. 589–591. Blast-furnace and open-hearth practice compared. Coke-oven gas as a fuel. Rolling mills in United States and England. (Abstract.) Paper read before West of Scotland Iron & Steel Inst.

Bessemer Process. The Bessemer Process For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ENGINEERING INDEX (Continued)

Making Steel, Arthur P. R. Wadlund. Trans. Am. Soc. for Steel Treating, vol. 1, no. 11, August 1921, pp. 682–689, 1 fig. Shows that the basic process is much more expensive than the acid process.

STEEL WORKS

Economic Location. Chicago's Relation to the Future American Steel Industry, Gerard de Geer. Chem. & Met. Eng., vol. 25, no. 8, August 24, 1921, pp. 325–328. Analysis of economic location of a steel industry in view of modern practice in coal economy, diminishing ore territory, increasing amount of scrap used, and greater influence of freight on finished product.

SUPERHEATERS

Performance. Steam Superheaters, Arthur D. Pratt. Jl. Engrs. Club of Phil., vol. 38, no. 200, August 1921, pp. 291–299 and Discussion pp. 299–308. Discusses construction and performances.

SWAGING

Cold. Methods Employed in Making Swaging Dies. Machinery (Lond.), vol. 18, no. 461, July 28, 1921, pp. 503–505, 8 figs. Subject of cold swaging.

T

TANKS

Collapse of Boston Molasses Tank. Eng. News-Rec. vol. 87, no. 9, Sept. 1, 1921, pp. 372–373. It is claimed that collapse was due to great overstress of tank shell.

TEMPERATURE CONTROL

Apparatus. The "Samson" Automatic Temperature Regulator. Engineering, vol. 112, no. 2904, Aug. 26, 1921, p. 307, 1 fig. Applied for operating, steam, gas, oil or water valves, or for controlling electric switches, and for regulation of room temperatures.

TESTING MACHINES

Alternating-Stress. The Haigh Alternating Stress Testing Machine. Engineer, vol. 132, no. 3422, July 29, 1921, pp. 116–117, 6 figs. Details of improved form.

TEXTILES

Microscopy of. The Microscopy of Textiles, Frederick J. Hoxie. Mech. Eng., vol. 43, no. 9, Sept. 1921, pp. 592–593, 3 figs. Notes on imbedding, sectioning and photographing. Points out that many irregularities in textile spinning, weaving and finishing, now a matter of mystery, can by photomicrographic records, be brought into realm of fact.

TIME STUDY

Drop-Forge Shop. Eliminating Unproductive Time in Industry. Eng. & Indus. Management vol. 6, no. 8, Aug. 25, 1921, pp. 205–207, 2 figs. Possible increase in production is emphasized by example of the drop-forge shop at Mare Island Navy Yard.

Human and Mechanical Elements of Work. Measuring the Human and Mechanical Elements in Manual Work, L. Arthur Sylvester. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 141–144. Discusses natural relation between time and human labor.

Organization. How to Conduct a Time Study Organization, Chester D. Buoy. Indus. Management, vol. 62, no. 2, Aug. 1, 1921, pp. 104–105. Notes on purpose of time-study department, and qualifications for a time-study man.

Standard Time. "Standard Time" in Planning and Production, Waldo Lyon. Management Engrg. vol. 1, no. 2, Aug. 1921, pp. 105–108, 5 figs. How it is used to eliminate delays, estimate output and compare results of machine and department operation.

Wooden Knife Handles. Time Studies on Wooden Knife Handles, Philip Bernstein. Indus. Management, vol. 62, no. 2, Aug. 1, 1921, pp. 76–82, 11 figs. Author analyzes in detail operations on knife handles of various woods, data and conclusions being derived from actual experience.

TOOL STEEL

Specifications. Standardizing Specifications For Tool Steel, Charles M. Brown. Trans. Am. Soc. for Steel Treating, vol. 1, no. 11, August 1921, pp. 666–672. Discusses specifications in use, also content of tungsten, vanadium, phosphorus, sulphur, etc.

TRACTORS, FARM

Types. Mechanical Power in Agriculture (La Motoculture) F. Mirès. La Vie Technique & Industrielle, vol. 2, no. 23, Aug. 1921, pp. 401–409, 14 figs. Describes various types of tractors.

TRAIN HEATING

Electric Trains. Steam-Heating Electric Trains in Switzerland, William A. Rosenberger. Elec. Ry. Jl., vol. 58, no. 6, August 6, 1921, pp. 206–207, 2 figs. Single-phase current at 15,000 volts is applied directly to water in specially designed boiler.

TRANSPORTATION

Interdependence of Various Forms. Interdependence of the Various Forms of Transport, Philip Burtt. Jl. Inst. of Transport, vol. 2, no. 5, March 1921, pp. 233–247, 2 figs. Discusses ocean transport and railway traffic, light and heavy railways, inland waterways and other forms of transport.

TYPE-CASTING MACHINERY

Monotype. Building Type Casting Machinery. Eng. Production, vol. 3, nos. 46 and 47, Aug. 18 and 25, 1921, pp. 157–162 and 181–186, 27 figs. Methods in monotype factory of the Lanston Monotype Corp., Ltd.

V

VALVES

Gate, Electrically Operated. Electrical Operation of Gate Valves, Payne Dean. Fire & Water Eng., vol. 70, no. 8, Aug. 24, 1921, pp. 343–344, 4 figs. Value of quick electrical control through special devices. Description of control system.

Pump, Automatic. Investigation of Automatic Pump Valves and Their Effect on Performance of Pump (Untersuchung selbsttätiger Pumpenventile und deren Einwirkung auf den Pumpengang), Ludwig Krauss. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 233, 1921, 112 pp., 172 figs. Deals will all conditions occurring in practice in different types of valves, based on experiments on six different kinds, carried out in machine laboratory of Dresden Technical Acad. Bibliography.

VENTILATION

Duct Systems. The Meier Chart, A. C. Pallot. Domestic Eng., vol. 41, no. 32, August 1921, pp. 115–120, 3 figs. Describes method of designing ventilation duct systems.

Nozzle or Air-Duct. Comparative Tests with a Nozzle and Air-Duct Ventilators (Vergleichende Versuche mit einer Düse und Luttenventilatoren), O. Leidenroth. Glückauf, vol. 57, no. 17, Apr. 23, 1921, pp. 391–393, 2 figs. Results of experiments with a jet blower and air-duct ventilator demonstrate superiority of former. Advantages of the described Höing nozzle.

VISCOSIMETERS

Gümbel. Determination of Absolute Viscosity with the Gümbel Viscosimeter (Zur Bestimmung der absoluten Zähigkeit mit dem Gümbelschen Zähigkeitsmesser), Ludwig Schiller. Zeit. für technische Physik, vol. 2, no. 2, 1921, pp. 50–52. Deals with apparatus developed by Gümbel and described in same journal (vol. 1, 1920, p. 72), and method of calculating absolute viscosity from velocity of flow through apparatus. Comparison with the Engler viscosimeter.

W

WAGES

Incentive vs. Production Basis. Incentive or Production Basis of Wage Payment—III, Henry H. Farquhar. Am. Mach., vol. 55, no. 9, Sept. 1, 1921, pp. 344–348, 3 figs. Assignment and recording of production; coöperation with workman; fitting system to conditions; coöperation of executives.

Premium System. The Premium Wage Payment, System, C. B. Lord. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 108–110. Principles and advantages of Halsey premium system.

Rate Determination. An Analytic Method for Determing Wage Rates, Edward Peterson. Management Eng., vol. 1, no. 3, Sept. 1921, pp. 146–148. Notes on determination of day-work and piece-work rates.

WARFARE

Incendiary. Incendiaries in Modern Warfare, Part II, Arthur B. Ray. Jl. Indus. & Eng. Chem., vol. 13, no. 8, August 1921, pp. 714–722, 27 figs. Description of shells, bombs, flame projectors, etc.

WASTE ELIMINATION

Automatic Machinery, Use of. Eliminating Manufacturing Waste With Machinery, J. E. Hires. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 410–412. Recognition of importance of engineering research and extensive use of automatic machinery as means of eliminating wastes in labor, time and materials.

Industrial. The Elimination of Construction Wastes, George W. Burpee. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 394–396. Comprehensive dollars-and-cents analysis of preventable wastes in construction industries and thorough understanding of responsibility imposed upon contractor, owner, architect, engineer and workman.

Waste due to Poor Engineering and Management, Dexter S. Kimball. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 375–377. Sound engineering practice and competent management are said to be most effective methods of eliminating waste. Accurate cost records of what has been done should make possible prediction of improved results.

Metal Trades Industry. Waste in the Metal Trades Industry, Fred J. Miller. Management Eng., vol. 1, no. 3, Sept. 1921, pp. 135–140, 4 figs. Abstract of field report on elimination of waste in industry based on studies in sixteen representative plants.

Research, Benefit of. The Role of Research in Waste Elimination, Harrison E. Howe. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 379–382. Encouragement of fundamental research in America said to be more urgently needed than stimulation of industrial research. Fallacy of curtailing research and disrupting organization in times of Industrial depression. Examples of waste eliminated by research.

WASTES

Industrial. Waste and Inefficiency in the Industries. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 433–448. Series of short articles by industrial leaders featuring outstanding causes of waste in various industries. Frank confessions of inefficiency due to wide variety of causes.

WATCH MANUFACTURE

Machines for. Automatic Machines in a Watch Factory, Fred R. Daniels. Machy. (N.Y.), vol. 27, no. 12, Aug. 1921, pp. 1093–1097, and vol. 28, no. 1, Sept. 1921, pp. 25–29, 14 figs. Machines, devices and methods employed in plant of Waltham Watch Co., Waltham, Mass.

WATER POWER

Canada. Canada's Fuel and Water Power Problems. Engineer, vol. 132, no. 3418, July 1, 1921, pp. 4–6, 4 figs. (Abstract.) Statements respecting relation of water power to Canada's fuel problems, published by Dominion Water Power Branch of Can. Dept. of Interior. Examples of waste eliminated by research.

Water Powers of the Prairie Provinces, C. H. Attwood. Jl. Eng. Inst. Can., vol. 4, no. 8, Aug. 1921, pp. 437–440. Resources, administration and market.

Geology and. Geology and the Hydroelectric Utilization of Water Falls (La Géologie et l'Aménagement Hydroélectrique des Chutes d'Eau), W. Kilian. La Houille Blanche, vol. 20, no. 53–54, May-June 1921, pp. 81–90, 9 figs. Discusses cement work along the rivers. (Concluded.)

WEIGHTS AND MEASURES

Accurate Equipment. The Essentials of Weighing in Industry, Herbert T. Wade. Management Eng., vol. 1, no. 3, Sept. 1921, pp. 129–134, 8 figs. Points out dependence of industry upon weighing, and advantages of good weighing practice and equipment. An example of routine weighing.

WELDING

Processes, Comparison of. The Present Status of Modern Welding Processes and Their Economy (Zum heutigen Stand der neueren Schweisseverfahren und ihrer Wirtschaftlicheit), Paul Schimpke. Betrieb, vol. 3, no. 20, July 10, 1921, pp. 620–626, 11 figs. Review and comparison of different processes, their useful scope, efficiency and cost.

[See also ELECTRIC WELDING; ELECTRIC WELDING, ARC; ELECTRIC WELDING, RESISTANCE.]

WELFARE WORK

Coöperative Stores. Food as a Factor in Industrial Morale, John T. Bartlett. Indus. Management, vol. 62, no. 2, Aug. 1, 1921, pp. 83–88, 3 figs. It is claimed that the savings a coöperative store or farmers' market accomplish are equivalent to a wage increase.

Savings Plans. Thrift Encouragement by Employers—II and III, Leonhard Felix Fuld. Indus. Management, vol. 62, nos. 2 and 3, Aug. 1 and Sept. 1, 1921, pp. 93–94, and 139–140, Aug.: Discusses advantages of having employee authorize regular deductions from his pay, these deductions to be put into his savings account. Sept.: Bonus systems; savings and loan associations; the employer's position.

WIRE DRAWING

Dies for. Wire Drawing Dies With Connected Guides (Filières d'Étirage a Touches Rapportées), A. Catherine. L'Outillage, vol. 219, nos. 29 and 31, July 21 and Aug. 4, 1921, pp. 795–797, 12 figs., and 839–840, 8 figs. Describes improved methods of wire drawing and construction of guides.

Nail-Making Factory. Wire Drawing and Nail Manufacture. Eng. Production, vol. 3, no. 47, Aug. 25, 1921, pp. 175–177, 7 figs. Plan and methods of a Belgian Factory.

WIRE ROPE

Care of. Instruction in the Care, Uses, and Inspection of Flexible Steel Ropes, H. C. Boynton and W. Voigtlander. Jl. Engrs'. Club of Phila., vol. 38–7, no. 199, July 1921, pp. 274–279. Discusses production and treatment of steel, manufacture of wire rope lubrication and inspection.

WOMEN WORKERS

New Avenues of Employment. The New Place of Women in Industry—VI, Ida M. Tarbell. Indus. Management, vol. 62, no. 2, Aug. 1, 1921, pp. 106–108. Discusses new professions which have opened for women as outgrowth of expanding interest in personnel work.

WOOD

Drying. The Artificial Drying of Timber (Die künstliche Trocknung von Nutzhölzern), Otto Brandt. Der praktische Maschinen-Konstrukteur, vol. 54, no. 24, June 16, 1921, pp. 185–200, 23 figs. Notes on composition of wood and nature of wood drying; steaming; construction and equipment of dry kilns with forced hot-air circulation; plants for drying lumber loaded on cars; heat and air requirements for wood-drying plants; stacking of timber; artificial drying methods with electricity, by chemical means, and through cooling with aid of refrigerating plant.

WOOD PRESERVATION

Mine Timbers. Comparative Tests with Preservation Processes for Mine Timbers (Vergleichsversuche mit Imprägnierungsverfahren für Grubenholz), O. Dobbelstein. Glückauf, vol. 57, no. 26, June 25, 1921, pp. 601–607, 18 figs. Final report of special testing committee on investigation of wood impregnated in 1913 and 1914 and installed in two mines, which was examined annually for the five succeeding years.

WOODWORKING INDUSTRIES

Yield Values. "Yield Value" Variations in Woodworking, W. L. Churchill. Management Eng., vol. 1, no. 1, July 1921, pp. 17–21, 6 figs. How they affect profits due to sliding scale of lumber values.